JOURNAL
OF THE
WASHINGTON ACADEMY OF SCIENCES

VOL. 48 January 1958 No. 1

MINERALOGY.—*Progress in titanium research.*[1]

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My first duty is to express my pleasure on being called to give the Burgess Memorial Lecture before the Washington Chapter of the American Society of Metals. Dr. Burgess and I had one point of contact in the first decade of this century that was of inestimable importance to me. It dealt with the subject of titanium research.

The motivation behind the development of titanium research in 1906 was based on the information that this metal had a melting point around 6,000°. It is quite immaterial whether the scale of temperature was Centigrade or Fahrenheit, as later operations showed. If this high melting point could be confirmed, it was obvious that titanium could join molybdenum and tungsten, which at that time were under development for filaments in electric lamps.

As we now know, the information was false. My own experiments led me to conclude that the melting point of the titanium produced was between 1,800° and 1,850°C., measured on equipment that would scandalize you today.

The reactions of the administration to the disappointing news was not calculated to raise the ego of the experimental observer—in this case myself. It was obvious that I must have some confirmation on my melting-point data. It so happened that Dr. Burgess was working on the melting points of refractory elements at the Bureau of Standards. A platinum or an iridium strip was heated under controlled conditions in an atmosphere of hydrogen with visual observation of the melting points of materials placed thereon. Samples of titanium (sodium reduced) were supplied by Dr. Von Wartenberg and by myself.

Von Wartenberg	Hunter
1,778°	1,790°
1,807	1,785
1,815	1,785
Mean 1,800	1,787

The probable melting point was given by Dr. Burgess as 1,795 + 15.

Recent information from the Armour Research Foundation gives the melting point of titanium in constitutional diagram as 1,732°C. There would still seem to be some room for argument here.

But let us turn now to the subject of this lecture—Research and Development in the Titanium Industry. There are three aspects I shall briefly review—Where have we come from? Where are we now? Where do we expect to go in the future?

TITANIUM—GENERAL

On an earlier occasion I have given you our attempts to develop a titanium industry (in 1906–1916)—but born 50 years too soon. The industry had to await the later development of melting under argon or helium, which at the earlier date were laboratory curiosities. But a still greater incentive to development was the desire of industry for airborne metals, with the Federal Government and the aircraft industry leading the way in the development. From the earliest disclosures of the Du Pont Co. in 1948 to the present time the unlimited resources of the

[1] Eighth Annual Burgess Memorial Lecture, Washington Chapter, American Society for Metals.

Federal Government have been made available to the industry.

The metal has no single property that is outstanding, but it has an optimum series of combinations. It is strong, light, ductile, corrosion resistant, and expensive. It is considered to be indispensable for national defense. Its military value is estimated at $20 to $50 per pound for military aircraft and when the weight margin is tight, higher premiums can be justified. Its civilian value is given as two to three times that of the materials it can replace. The life expectancy is often much longer, but at present nonmilitary operations consume less than 10 per cent of industrial production.

Major problems of the past that are still with us today include melting operations and scrap recovery. Melting at 3,100°F., titanium reacts with every known refractory to become embrittled thereby. Present research in skull melting may or may not give the answer to these difficulties.

PROGRESS IN THE INDUSTRY

The shipment of titanium mill products to industry in recent years is given below:

1950	2,000 pounds
1952	40,000 pounds
1953	200,000 pounds
1954	2,500,000 pounds
1955	3,900,000 pounds
1956	10,000,000 pounds (estimated)

No metallurgical operation of which I am aware has ever had so phenomenal a yearly growth from 2,000 pounds in 1950 to 10 million in 1956. Future projections to 35,000 tons in 1958 have been made.

The important factor of prices for sponge, billet, and sheet from 1951 to the present appear in Fig. 1. It is clear that the industry is moving ahead with increased volume of production coupled directly with a lowering in cost of materials produced.

Now let me give you "What Industry Thinks of Itself."

WHAT THE TITANIUM INDUSTRY THINKS OF ITSELF

C. I. Bradford, president of Rem-Cru Titanium Inc., speaking before a recent Mining Congress made some pertinent remarks on titanium progress.

The year 1956 can be summarized as the year in which the aircraft industry gave titanium a solid vote of confidence as a standard engineering material for production components. This vote of confidence resulted in a three fold increase in demand for titanium mill products in 1956 over 1955. Final industry figures should clear the 5,000-ton mark. The same trend appears certain to continue in 1957. A minimum demand of 10,000 tons of mill products is our present estimate.

Chase Brass & Copper will melt and fabricate the titanium metal. Production of billets is slated for late 1958.

Since costs per annual ton of capacity in Electromet's sodium reduction plant are reputed to be at the rate of $4,125 per annual ton this commitment of 41 million should produce 10,000 tons per year.

Japanese sources are expected to continue or increase their output of 2,500 tons/year.

I have no figures at hand on the melting capacity of Titanium Metals Corporation of America, Republic Steel Corporation, and other melting plants. Rem-Cru reports its melting capacity to be 6,000–7,000 ingot tons per year.

In the fabrication field Certificates of Necessity have been issued to T.M.C.A. and Eastern Stainless Co. for 50 inch Sendzimir Cold Strip Mills for rolling and processing titanium.

T.M.C.A. considers this development to be particularly urgent in view of the transition of aircraft and missiles into high speed flight where high skin temperatures cause present materials to lose their strength. In addition, titanium and its alloys have been developed and evaluated for incorporation into jet engines. There would seem to be little question that the present industrial plants will be able to meet all potential demands of the titanium industry.

TITANIUM ALLOYS

The compelling motive, in engineering construction, for the use of titanium as a replacement for the more common materials of construction comes from the high strength-weight ratio of this material at temperatures up to 1,000°F., while in the chemical industry the relative resistance to corrosion

plays the predominant role. The developments in recent years in the titanium alloy field have gone a long way in establishing titanium priority.

THE 6 ALUMINUM, 4 VANADIUM ALLOY

One of the more important alloys is Ti-6Al-4V developed by Armour Research Foundation under government sponsorship. Early studies showed it to have an excellent combination of tensile strength and ductility, with good resistance to impact and high strength at elevated temperatures. Production was initiated in 1954 and at the present time the alloy is one of the most popular of the commercial compositions. It is being used in large quantities in ordnance, airframe and aircraft engine applications and is currently available as wire, sheet, bar, and forging billet as well as other mill products.

The mechanical properties of alloy Ti 75 A of the year 1950 and of Ti-6Al-4V (annealed of 1955) are compared in the following table:

	Room temperature	600°F
1950 Ti 75 A		
Tensile strength	98,000 psi	45,000 psi
Yield	81,000 psi	28,000 psi
Elongation in 2"	23 psi	38 psi
1955 Ti 6 Al 4V (annealed)		
Tensile strength	143,000	105,000
Yield	131,000	93,000
Elongation in 2"	16	19

By proper heat treatment a tensile strength of 200,000 psi can be obtained. The more recent data on the alloy 155 A show improvements in properties of a similar character.

EFFECT OF HEAT TREATMENT ON THE TENSILE PROPERTIES OF TI 155A 5 AL, 1.5 FE, 1.5 MO, 1.5 CR

	Annealed	Heat treated*
Tensile Strength	159,000	208,000
Yield strength	155,000	197,000
Elongation in 1"	23	10
Reduction in area	45	2.6

* Heat treatment—Solution temp. 17,00°F—water quenched aged 4 hours at 1,000°F.

With such high strength alloys as these, titanium can compete on a strength. weight ratio basis with most of the present materials of construction. Fig. 2 shows the marked superiority of Ti-6Al-4V over aluminum alloys and stainless steels in temperature ranges from room to 1,000°F. With such figures as these, titanium alloys become important factors in engineering construction and will assume a wider significance.

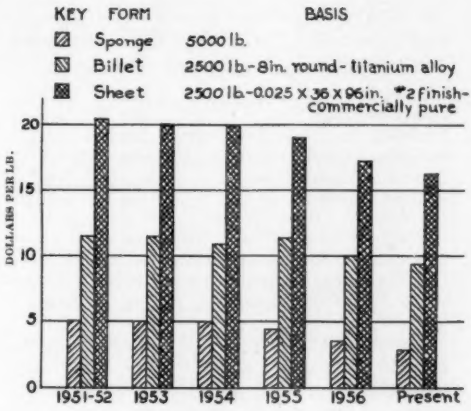


FIG. 1

Production of Titanium Metal

Sodium or magnesium as a reducing agent.—The earlier methods for the production of sponge titanium from the tetrachloride involved the use of magnesium as the reducing agent. Later operations have used sodium as the reducing agent.

The costs of the operation by the two methods are said to be practically identical by Kroll.[2] The cost of the titanium chloride represents 50 per cent of the sponge price and the sodium or magnesium contributes 20 per cent to the cost of the titanium product.

In view of this, consumers and potential users are asking: Can we design more titanium into our aircraft, our engines, our chemical plants, with the assurance that there will be an ample supply of titanium to meet our requirements. The answer when we look at the outlook for 1957 is definitely "yes."

Behind this optimism is the assurance of adequate supplies of raw materials for 1957. The situation by mid or late 1957 will be:

[2] Metallurgical Rev., 1956, vol. 1:1-3, 291.

	Annual Tons	Plant cost $ per annual tons*
Cramet Inc.	6,000	4,150
Dow Chemical	1,800	—
Du Pont	7,200	5,450
National Distillers	5,000	—
Titanium Metals Corp.	9,000	4,175
Union Carbide	7,500	4,125
Total capacity	36,500	

* The figures for plant cost per annual ton were taken from TML Report No. 52, Sept. 7, 1956.

Recent estimates by the personnel of the Bureau of Mines in Boulder City, Nev., indicate that the cost per annual ton of new plant capacity may be as low as $2,500.

Another development in the sponge picture comes from the public press. Chemical and Engineering News, December 31, 1956, and Wall Street Journal state that Allied Chemical & Dye and Kennecott Copper plan a jointly owned company to produce and sell titanium for uses ranging from jet aircraft to vacuum tubes.

Initial investment is expected to be $40,000,000. The installation is to make titanium tetrachloride, titanium sponge, and billets of titanium metal. Allied Chemical says the company will use a new continuous process which employs sodium to reduce titanium tetrachloride to sponge by processes represented to be continuous.

The sodium reduction develops one third more heat than the reduction by magnesium. The sodium requires one third more electrical energy for its production than magnesium does. So far as this observer knows magnesium chloride is recycled to recover magnesium but no recycling is undertaken for the sodium chloride.

Sodium chloride melts at 800°, and magnesium chloride at 720°C., but sodium reductions can be carried on at much lower temperatures than 800°C. since the subchlorides of titanium form complexes ($TiCl_3 3NaCl$) which melt at 554° and dissociate at 600°C. Much of the sodium reduction can in fact be carried on in the solid state as will appear in a later section of this paper.

Sodium metal is much easier to purify than magnesium. Ceramic filters can be used to remove oxides. This is not possible with magnesium. Further, sodium can be pumped to the spot where it is to be used. In leaching operations sodium chloride solutions do not attack titanium sponge. Excess reducing

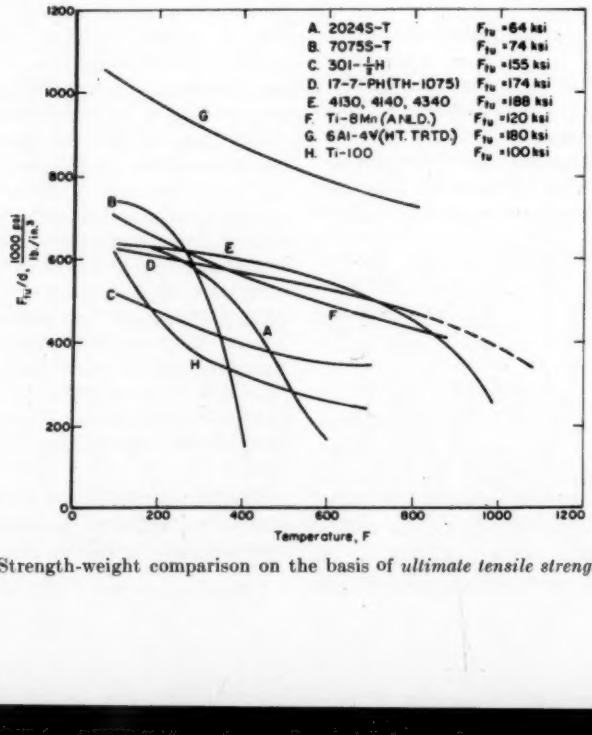


FIG. 2.—Strength-weight comparison on the basis of *ultimate tensile strength* density

agent can be kept to 5 per cent with sodium whereas with magnesium it may amount to 15 per cent. Leaching with water is cheaper than distilling off magnesium chloride but the hydrogen content of the leached sponge may be high and must be eliminated by other means. The recycled magnesium is said to make an important cost saving.

Other interesting observations are that molten sodium chloride dissolves 20 per cent of sodium at 850°C. which would separate as a fog on cooling.

Titanium tetrachloride has practically no solubility in molten NaCl. Its vapor pressure is so high that it rapidly boils off. The lower chlorides with higher boiling points appear to dissolve in all proportions.

The present Kroll process is the only well established procedure for reducing titanium tetrachloride with metallic magnesium. But the sodium reduction can follow several procedures of which the following are more important.

SODIUM REDUCTION OF TITANIUM TETRACHLORIDE

(1) Low temperature operations at 200°C. This is the "high surface" sodium operations described in advertising literature by National Distillers to produce subchlorides of titanium or even titanium metal. In this procedure when liquid sodium is stirred into solid salt, it coats each crystal. The tetrachloride when introduced reacts with this sodium layer to produce the dichloride. If this material is then subjected to further additions of sodium metal and then set aside for hours to complete the reduction, the finely divided titanium powder will grow larger crystal grains which can be leached with water without difficulty. Little or no external energy other than the heat of the reaction is required to complete the process. Similar processes are described by J. P. Quinn[3] of Imperial Chemical industries.

(2) The reaction can be carried out at 800°–850°C. At 650°–750°C. the salt complex of NaCl and $TiCl_2$ is molten. At 805°C. the molten bath will produce needles of titanium with a Brinell hardness of less than 70.

(3) At still higher temperatures the titanium chloride and sodium can react and produce droplets of solidified titanium such as appeared in the early bomb experiments.

DISPROPORTIONATION

In many of these reactions with the subchlorides of titanium disproportionation probably plays an important role.

From Report No. 20-88, Jet Propulsion Lab., California Inst. Tech., I quote the following: "Hydrogen may be used to reduce $TiCl_4(g)$ to $TiCl_3(s)$ at low temperatures. While the reaction is thermo-dynamically complete at room temperatures, the rate is negligible."

$TiCl_3(s)$ and $TiCl_2(s)$ are not reduced appreciably by hydrogen at elevated temperature since these compounds are stronger reducing agents than hydrogen. When these compounds are heated disproportionation occurs as the dominant reaction.

Metallic titanium may be formed completely from such reactions at temperatures as low as 600°C.

$TiCl_2$ disproportionates and vaporizes as follows:

$$2\ TiCl_2(s) \rightarrow TiCl_4(g) + Ti$$

$$3\ TiCl_2(s) \rightarrow 2\ TiCl_3(s) + Ti.$$

Laboratory analysis of the product after the reaction showed it to contain more than 95 per cent of titanium metal.

But $2\ TiCl_3 \rightarrow TiCl_4(g) + TiCl_2(s)$, which reacts further to give metallic titanium. It is highly probable that the titanium precipitating from a sodium chloride molten salt will prefer to precipitate on titanium lattices that already exist in the solution. By such means then crystals of titanium will continue to grow, as we have already observed.

OTHER REDUCTION PROCEDURES

The simplest procedure for producing titanium would seem to be the reduction of the abundant titanium dioxide (rutile).

Laboratory investigations of Chretien and Wyss[4] indicate that magnesium will reduce the dioxide to monoxide (TiO) while calcium will complete the reduction to titanium metal.

Similar procedures are the subject of

[3] British Patents 717930, Nov. 1954; 720517, Dec. 1954.

[4] Chretien and Wyss, Compt. Rend. **224:** 1642. 1947.

patents[5] to Dominion Magnesium Ltd. I have no information on large scale industrial operations.

There have been many attempts to produce titanium by electrolytic methods. The following cell feeds have been used—titanium tetrachloride, titanium oxide, or potassium titanium fluoride.

The ideal electrolytic cell will require a diaphragm or its physical equivalent to prevent the anodic product, oxygen or chlorine, from reoxidizing the titanium subsalts produced at the cathode. This introduces many complications that to date have not been adequately met.

Real progress in electrolytic recovery and refining has been made by the Bureau of Mines group in Boulder City, Nev., which is described in the next section.

ELECTROLYTIC REFINING OF TITANIUM BUREAU OF MINES—BOULDER CITY

An active research group under the direction of Messrs. Blue and Baker has presented some outstanding results in the field of the electrolytic refining of titanium. The program began as an electrolytic operation for the refining of titanium scrap. The success has been so remarkable that the method gives promise of being hereafter an important phase in the extractive production of titanium metal from its basic ores.

The electrolytic cell designed and used by the Bureau is made from ½-inch mild steel plate—heated by Globar units and protected externally from oxidation by a spray coat of chromium aluminum alloy.

The electrolyte is a 5-per cent solution of titanium dichloride ($TiCl_2$) in sodium chloride maintained molten around 830°C. The minimum allowable current density is given as 550 amperes per square foot. Higher currents can be used in more concentrated solutions but the quality of the metal produced drops off at the higher current densities.

In a 4,700-ampere cell four cathodes of sheet steel were distributed along the longer axis of the cell. (The number could be indefinitely increased by lengthening the cell without interfering with regular operation.) This cell was actually running at 3200 amperes and was producing 2,800 grams of cathode titanium per hour at an energy consumption of 26–27 KWH per pound of metal. Much of this electrical energy was consumed in keeping the bath molten. It was estimated that a 10,000 ampere cell would maintain its temperature without external heat.

The material to be refined is thrown into the bottom of the tank. An anode connection to the outside of the tank completes the electric circuit. The deposit continues without interruption for four hours with practically no attention. Helium supplies the inert atmosphere. In argon the sublimation of salt is greater for reasons unknown.

The deposit is drained for 15 minutes in the inert atmosphere above the cell and cooled for one hour when it can be safely removed. The drag out is unusually small—approximately two-tenths pound of salt per pound of metal withdrawn. The deposit which is highly crystalline in character is readily washed with water acidulated with hydrochloric acid.

A 1,000-ampere cell ran with a current efficiency of 78 percent and a 4,000-ampere cell ran 70 days at 85 percent.

From a large number of runs (100 or more) 65 per cent of the product was less than 70 BHN, 22 per cent was plus 70 to 80 BHN, 5 per cent was over 100 BHN, 3 per cent between 100–140 BHN, and 5 per cent was over 140 BHN.

In the hands of the skilled operators at Boulder City there appears to be no difficulty in the continuous running of the cells. The engineering features in their simplicity are in strange contrast to some of the electrolytic monstrosities which I have seen in other laboratories.

I failed to mention that the starting material used in the runs just outlined was titanium scrap with a Brinell hardness of 350. As a means of upgrading scrap the operation was quite a successful one.

Chemical and Engineering News for December 31, 1956, carries a reference to the use of an electrorefining operation for scrap recovery by Mallory Sharon Titanium Company under the direction of Dr. R. S. Dean. The method followed would appear to be that indicated by the Boulder City Bureau of Mines.

[5] British Patent 664061, Jan. 1952.

A special importance attaches to this refining process in view of the prospect of refining cheap titanium or titanium alloys made by carbon, silicon, or metallothermic reduction of oxides. This electrolysis of soluble anodes for titanium refining offers new possibilities, the potentialities of which have still to be explored.

The approach to this problem is further developed in a recent brochure which I received from Chicago Development Corporation on Electrolytic Titanium from which I quote.

> A more practical method for the large scale reduction of titaniferous ores and slags is aluminothermic reduction.
>
> Economically, Sorel Slag is an excellent starting material for use in aluminothermic reduction as it is cheap, has a high percentage of titanium dioxide and forms a low melting titanium-aluminum iron alloy which can be separated easily from the oxide products after reduction. The Sorel slag, which is a black, lumpy material, is dried, ground to −100 mesh, mixed with aluminum scrap, and heated in an induction furnace to 1200° and 1300° C. Although the reaction is exothermic, added heat is necessary to allow the metal to coagulate and the resultant oxide products to form a slag at the top. Both a flux of 90% calcium fluoride and 10% sodium aluminum fluoride, and a flux of 50% calcium oxide, 45% calcium floride and 5% sodium aluminum fluoride have been used successfully.
>
> From a sorel slag with an initial composition of
>
> | | |
> |---|---|
> | 80% | TiO_2 |
> | 5.74% | FeO |
> | 3.2% | SiO_2 |
> | 4.7% | MgO |
>
> a reduced product was obtained which contained
>
> | | |
> |---|---|
> | Ti | 75.0% |
> | Al | 10.0% |
> | Fe | 7.5% |
> | O_2 | 3.2% |
>
> The material was bottom poured into an argon filled mold which casts the alloy into plates that can be hammer milled to the desired particle size as a feed for the electrolytic cell.
>
> In following up such investigations as this, the silicothermic reduction of titanium ores must also receive some consideration. In fact it lies well within the bounds of possibility that combinations of carbon, silicon and aluminum used as reducing agents can produce a satisfactory ferrotitanium product for ultimate electrolytic refining. A high concentration of titanium carbide in the resultant product would present some difficulties in carbon removal in the final electrolysis.

As a final word to the story I can say that the members of the Titanium Review Committee of the Materials Advisory Board, chairmaned by Dr. Frances C. Frary, in reviewing the annual progress in titanium extraction research are in accord in thinking that the recent development in electrolytic research at Boulder City represents the first major break-through in new titanium developments in the metal production field. It eliminates the chlorination feature of the expensive titanium tetrachloride. If the cheapest of our titanium ores can be converted by arc melting to ferrotitanium alloys, the electrolytic process can convert this product to a high-grade titanium which might be superior in quality to any metal produced to date by sodium or by magnesium reduction of the tetrachloride.

There will be a considerable time lag in getting such a process into competitive commercial production but the increasing market for titanium sponge will give present plants adequate opportunity to recoup their cost with the 5-year amortization.

I consider it of the greatest importance that the electrothermal reduction of titanium oxide and the electrolytic refining of the resulting alloy at the Boulder City, Nev., station of The Bureau of Mines should be adequately supported and that the experimental work be pushed as rapidly as possible.

In the light of these later developments, I believe that the future holds high promise for better and even cheaper titanium as an engineering material in production.

PALEONTOLOGY.—*Some Lower Ordovician monoplacophoran mollusks from Missouri.*[1]

ELLIS L. YOCHELSON, U. S. Geological Survey. (Communicated by H. A. Rehder.)

(Received August 6, 1957)

The discovery of a living representative of monoplacophoran mollusks (*Neopilina galatheae*) dredged from deep water off the west coast of Central America (Lemche, 1957, pp. 413–416) has aroused much interest among students of mollusks. Monoplacophorans previously had been known only as fossils in rocks of Cambrian through Devonian age. On the basis of the paired muscle scars found in the fossil shells the Monoplacophora have been interpreted as primitive mollusks that have not undergone torsion (Wenz, 1940; Knight, 1952). The soft anatomy of the Recent species *Neopilina galatheae* Lemche, confirms the supposition as to the primitiveness of the group.

At the same time, this discovery has emphasized the need for more study of the fossils. An unexpected feature of the Recent species, not reported from fossil taxa, is an asymmetrical coiled larval shell. Lemche (1957, p. 414) suggests that the Silurian genus *Pilina* Koken was characterized by an asymmetrical nucleus. Unfortunately, he based this opinion on drawing of a specimen which has long been lost, and this important detail cannot be checked.

I have examined the U. S. National Museum and the U. S. Geological Survey collections in the hope of finding some monoplacophorans that would provide information on early growth stages. Three specimens of one species were obtained which give some information on this subject. Specimens of two other species, showing well-preserved muscle scars, were also found. These three species, two of which belong to new genera, are described and figured below.

The collections of the U. S. National Museum contain numerous specimens of the Cambrian monoplacophoran *Scenella* Billings. The muscle scars of one species of the genus have previously been described (Rasetti, 1954). Some Middle Ordovician specimens, particularly types and figured specimens, are also in the collections, as are a few Silurian specimens. Upon preliminary examination, none of these specimens showed either muscle scars or details of the apical area.

During their tenure with the U. S. Geological Survey, the late Drs. E. O. Ulrich and Josiah Bridge obtained numerous Lower Ordovician gastropods for a proposed monographic study. In the course of this work nearly 200 specimens of monoplacophorans were collected from outcrops or were contributed by other institutions. The three species described below are from the Ulrich and Bridge collection.

No previously described species are referred to the new genera described below. Most North American monoplacophoran species were described between 60 and 70 years ago, and at the time little emphasis was placed on muscle scars by American writers. Thorough monographic treatment of the group, particularly restudy and reillustration of type specimens, is needed.

John W. Koenig, Missouri Geological Survey, provided information regarding the fossil localities. I am indebted to Dr. J. Brookes Knight for his ideas regarding the significance of these specimens. Photographs were taken by Nelson W. Shupe of the U. S. Geological Survey.

Class AMPHINEURA

Order MONOPLACOPHORA

Family TRYBLIDIIDAE

Subfamily TRYBLIDIINAE

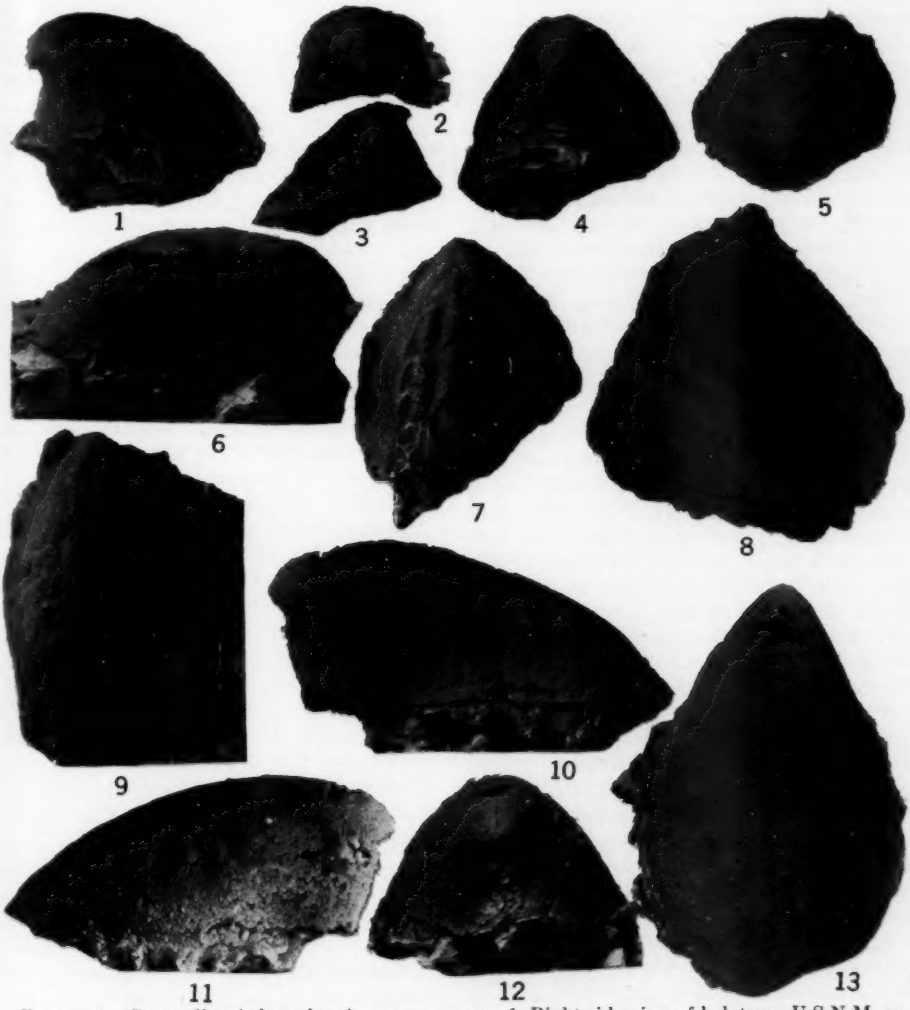
Cyrtonellopsis Yochelson, n. gen.

Type species.—*Cyrtonellopsis huzzahensis* Yochelson, n. sp.

Diagnosis.—Deep, cap-shaped monoplacophorans with a strongly curved asymmetrical apex not projecting far over anterior; dorsum smoothly curved; muscle scars unknown; shell and ornament unknown.

Discussion.—When these specimens were discovered in the collections, I was unable to place

[1] Publication authorized by the Director of the U.S. Geological Survey.



FIGS. 1–4.—*Cyrtonellopsis huzzahensis*, n. gen., n. sp.: 1, Right side view of holotype, U.S.N.M. no. 135181; 2, apical view of paratype, U.S.N.M. no. 135182; 3, apical view of paratype, U.S.N.M. no. 135183; 4, apical view of holotype.

FIGS. 5–9.—*Bipulvina croftsae*, n. gen., n. sp.: 5, Oblique top view of holotype, U.S.N.M. no. 135184; 6, side view of paratype, U.S.N.M. no. 135185a; 7, top view of holotype; 8, oblique side view of holotype showing bifurcation of apex; 9, top view of paratype.

FIGS. 10–13.—*Proplina cornutaformis* (Walcott): 10, Right side view of plesiotype, U.S.N.M. no. 135186a; 11, left side view of plesiotype; 12, apical view of plesiotype; 13, top view of plesiotype.

All figures twice natural size, except 2 (natural size) and 8 (three times natural size).

them generically. After examining photographs of them, Knight (written communication) suggested that they represented a new genus closely allied to the Devonian genus *Cyrtonella* Hall, 1879. Examination of specimens of *Cyrtonella* confirms this opinion. The similarity even extends to the asymmetry of the juvenile shell (Knight, 1941, pp. 95–96). The principal difference between the two genera is that *Cyrtonella* has a ridge on the dorsum, and *Cyrtonellopsis* has a smoothly rounded dorsum. Because of their strongly curved apex, these two genera are atypical of the Tryblidiinae (Knight, 1952, pp. 46–47). Further study may show that they should be placed in another subfamily or another family.

Cyrtonellopsis huzzahensis Yochelson, n. sp.

Figs. 1–4

Description.—Strongly curved monoplacophorans with a subcircular aperture; available specimens from about 2.0 cm to 3.5 cm in length, apex just overhanging anterior margin and strongly asymmetrical either sinistrally or dextrally; shell expanding rapidly so that it is relatively deep and completing about three-fourths of one whorl; aperture subcircular, the anterior part slightly compressed laterally; dorsum following a curve nearly the arc of a circle; shell unknown but presumably thin.

Discussion.—When the holotype is oriented with the aperture down and the apex toward the observer, the hooked apex bends strongly toward the right. On one paratype the apex is inclined to the right but is nearly symmetrical. On the other paratype, the apex is strongly inclined to the left. Several colleagues have examined these steinkerns, or internal shell fillings, and all agree that the specimens have not been deformed by compaction of sediment, deformation of strata, or other geologic features. The asymmetry shown can be considered as basic to the living animal.

If this assumption is granted, the specimens are significant for three reasons: (1) the hook-shaped apical filing preserved on these steinkerns is evidence that the early growth stages of the shell were curved for at least part of one whorl. As a steinkern is not always a true reflection of the exterior, it is reasonable to assume that the shell was more strongly coiled than is shown directly by the specimen. (2) The specimens show that in the Lower Ordovician at least one genus of monoplacophorans had an asymmetrical protoconch. Though the muscle scars of *Cyrtonellopsis* are unknown, the general form is so similar to *Cyrtonella*, the two taxa probably had similar musculature. (3) If the three specimens are a sample of a living population, they show that the asymmetry of the early whorls was variable among individuals.

Cyrtonellopsis huzzahensis strengthens the interpretation that the living *Neopilina galatheae* Lemche (1957, p. 4161, figs. 1–4) is a monoplacophoran. The coiled larval shell of that species is not atypical but is something that can be at least partly demonstrated from the fossil record. Comparison of *Cyrtonellopsis* with specimens of *Cyrtonella* has confirmed the individual variation of the asymmetrical protoconch in *Cyrtonella*. The taxonomic importance of the assymmetrical protoconch cannot be evaluated until more information is available regarding this feature in other genera. It is reasonable to consider the early growth stages of the monoplacophorans as a larval adaptation and as such, they have limited taxonomic usefulness.

Locality.—U.S.G.S. locality 238 (green),[2] Cambrian-Ordovician register. Huzzah Creek section, on Huzzah Creek 1 mile west of mouth of Dry Creek, on Missouri Highway 8, about 8 miles east of Steeleville. Mr. Koenig suggests that the section is probably in the SW¼SW¼ sec. 26, T. 38 N., R. 3 W, Crawford County, Mo. Collected by E. O. Ulrich and H. E. Dickout, August 23, 1906. The register lists the formation as Gasconade dolomite.

Catalogued specimens.—Holotype U.S.N.M. no. 135181. Paratypes U.S.N.M. nos. 135182, 135183.

Genus **Proplina** Kobayashi, 1933

Type species.—*Metaptoma cornutaforme* Walcott.

Diagnosis.—Laterally compressed monoplacophorans have the apex projecting far over the anterior margin of aperture; interior of shell with six sets of paired muscle scars, one pair anterior and high in the shell, four spaced uniformly along the sides of the shell, and one pair on the posterior slope.

[2] The Paleontology and Stratigraphy Branch of the U. S. Geological Survey maintains several locality registers for the various internal subdivisions. These are differentiated by colors on the locality numbers attached to specimens. The "green" series, Cambrian-Ordovician, are no longer in current use being superseded by an "orange" register.

Discussion.—Kobayashi (1933, p. 263) remarked that the muscle scars of this genus are "represented by an impressed band near the aperture." Actually muscle scars cannot be seen on the specimens he described, and cannot be seen on the primary types of *Proplina cornutaformis* (Walcott) (Knight, 1941, p. 274). Knight (1952, p. 47) placed the genus within the Tryblidiinae and in a footnote stated that he examined specimens of *Proplina* from the Ulrich and Bridge collection which showed monoplacophoran muscle scars. Though the importance of these specimens is obvious, they have never been previously described or figured.

Proplina cornutaformis (Walcott)

Figs. 10–13

Metoptoma cornutaforme Walcott, 1879, p. 129
Metoptoma cornutaforme Walcott. Lesley, 1889, p. 204, figs.
Triblidium cornutaforme (Walcott). Walcott, 1912, p. 263, pl. 41, figs. 12–14.
Proplina cornutaformis (Walcott). Knight, 1941, p. 274, pl. 4, figs. 2a–2c.
Proplina cornutaformis (Walcott). Knight, 1944, p. 437, pl. 174, fig. 11.

Description.—Laterally compressed ovoid, relatively deep monoplacophorans, with apex projecting over anterior apertural margin; available specimens from about 1.0 cm to 3.5 cm in length; aperture strongly compressed at anterior, moderately rounded at posterior, so that shell is wedge shaped when viewed from above; shell relatively deep, in the mature stage flattened on the dorsum in side view; outer surface with numerous, equally spaced concentric rugae, not reflected on the interior of the shell; apex only slightly curved; approximately one-fourth of shell projecting over anterior margin in early growth stages and nearly one-fifth of shell projecting at maturity; interior of shell with six sets of paired muscle; anterior muscle scars located about one-third of the distance from apex to posterior of margin, and relatively high in the cup; the first scar consisting of a sharp short depression in shell trending near 45° to the margin of the aperture and a posteriorly elongated slight swelling located behind the depression; the second to fifth sets of scars on the steep lateral sides, closer to the apertural margin than the first set, these four pairs of scars nearly equally spaced, with the second scar below the swelling noted above, and the fifth posteriorly, some three-fourths of the total length of the shell; the second pair of scars faint and obscure in detail; the third through fifth formed of elongate narrow depressions inclined near 60° to the margin of the aperture each with a posterior swelling, but neither the depression nor swelling having sharp margins; the sixth pair of scars on the posterior slope, somewhat wider than the others, widening and dying out toward the posterior margin, but continuing as faint furrows up along the dorsum above the general level of the other scars for some two-fifths of the length of the shell; interior of shell with a flattened area on dorsum just anterior to furrows of posterior set of muscles.

Discussion.—The above description is based on reexamination of the types and topotypes, all from limestone and showing the external ornament and general form, supplemented by chert steinkerns preserving the impression of the shell interior. One measurement suggests that the shell covering these steinkerns was about 0.4 mm thick. This thickness of shell would account for most of the differences of shape between the calcareous shells and the steinkerns. The possibility remains that the steinkerns may represent a distinct species. Perhaps the single most important difference is that the steinkerns do not reflect the rugosities shown in the shell exterior of the limestone specimens. In the present state of our knowledge of the monoplacophorans, however, it seems wiser to construe the species broadly than name a new species.

In addition to the type, three other American species have been referred to this genus. *Proplina cornutaformis* has a less elongate apex than *P. acuta* (Whitfield) (1889, p. 45, pl. 7, figs. 9–11) and a more elongate apex than *P. unguiformis* (Ulrich, in Ulrich and Scofield) (p. 843, pl. 61, fig. 42–44). The type species is lower and has a steeper slope of the shell below the apex than does *P. barabuensis* (Whitfield) (1878, p. 60) *Proplina cornutaformis* (Walcott) differs from *P. bridgei* Kobayashi (1933, p. 263, pl. 5, fig. 2) described from southern Manchuria, in being relatively and significantly higher. It differs from *P. ampla* Kobayashi as figured (Kobayashi, 1933) on plate 4, figure 2, in having the posterior slope not abruptly set off at an angle. The specimen of *P. ampla* figured on plate 5, figure 4, probably should be referred to *Cyrtonellopsis*.

Locality.—The chert steinkerns showing muscle scars, one of which is figured, are from U.S.G.S. locality 242c (green), Cambrian-Ordovician

register. Teagues Creek, Webster County, Mo. The specimens probably were obtained at or near the Teagues Creek lead workings located in the SW¼SE¼ sec. 6, T. 29 N., R. 17 W. Specimens were collected in 1891 by W. P. Jenny. The register lists the formation as "First Magnesian limestone." A label with the collection in Josiah Bridge's handwriting states "Lower Cotter."

Catalogued specimens.—Plesiotypes, U.S.N.M. nos. 135186a–135186v.

Bipulvina Yochelson, n. gen.

Type species.—Bipulvina croftsae Yochelson, n. sp.

Diagnosis.—Low, spoon-shaped monoplacophorans having the interior of the dorsum flattened for more than half of its length and set off from the anterior and posterior slopes; apex strongly anterior, just projecting over apertural margin; five pairs of subtriangular lateral muscle scars located relatively high on lateral slopes, with some additional markings on anterior slope; ornament unknown; interior of shell with two furrows parallel to lines of muscle scars.

Discussion.—Bipulvina fits clearly within the Tryblidiinae as listed by Knight (1952, p. 46, 47). Even though the external ornament of *Bipulvina* is unknown, it can be distinguished readily from other members of the subfamily. The shell is lower and much less curved than that of *Cyrtonella* Hall, 1879, or *Vallatotheca* Foerste, 1914. Both *Vallatotheca* and *Pilina* Koken, 1925, have strong rugosities which would be reflected on the shell interior; such rugosities are missing from *Bipulvina*. The apex of *Bipulvina* is less pointed than that of *Drahomira* Perner and *Proplina* Kobayashi, 1933, *Helcionopsis* Ulrich and Scofield, 1897, is not well known, but seemingly has a lower shell more strongly curved along the dorsum.

Bipulvina is closest to *Tryblidium* Lindström, 1884, in shape, but has a different musculature than that genus, possessing only five pairs of muscles, rather than six. In some ways *Bipulvina* is a more complex shell than *Tryblidium* as it has a different sort of musculature at the anterior than on the main part of the body. *Pilina unguis* (Lindström) shows differentiation of the anterior scar or scars (Lindström, 1880, pl. 9, fig. 2) but the anterior slope is unlike that of *B. croftsae*. It is tempting to homologize the six or eight muscles of the tryblidiids with the individual plates of the Amphineura (Knight, 1952, p. 22) but *Bipulvina* shows that, in detail, such homology is not exact or necessarily correct.

Bipulvina croftsae Yochelson, n. sp.

Figs. 5–9

Description.—Low, spoon-shaped monoplacophorans with two depressions on dorsum of shell interior paralleling the two lines of muscle scars; available specimens about 2.5 cm in length; aperture oval, rounded anteriorly and posteriorly, wider at the latter end; cast of apex relatively blunt, just overhanging the anterior margin; ornament and thickness of shell unknown; dorsum of steinkern, when viewed in profile, flattened and gently inclined, bending abruptly at the anterior slope and less abruptly at the longer posterior slope; five distinct sets of paired muscle scars located relatively high in the shell between the anterior and posterior slopes, the most forward set being just posterior to the anterior slope; muscle scars in shell subtriangular with a point toward the apex, deepest at the point and shallowing posteriorly, the first muscle scar longer than those posteriorly, each scar crossed by several growth lines concave forward, the lowermost edges of all the muscle scars joined and still farther sunk into the shell; central to the lines of muscle scars there are two shallow linear furrows coalescing on the anterior slope and dying out posteriorly, the area of the shell between these rounded depressions being raised and flattened; anterior slope of shell interior with several markings, possibly muscle scars, but fainter and smaller than those posteriorly; markings in the form of two paired ridges and depressions, occurring anterior to first clear large muscle scar, with a third smaller depression just posterior to the apex and above the apical construction noted below, with two flattened subtriangular shell thickenings projecting inward near the apex; evidence of a short median septum anterior to these projections; a set of paired crescent shaped markings occurring at the extreme anterior under the apex where the shell begins to flare out near the margin; a pair of elongate weltlike ridges inclined 30° to the margin occurring anteriorly about midway between the apex and the first clear muscle scar, but relatively close to the margin; and a pair of shorter ridges occurring below the first large muscle with other similar,

though fainter, ridges posteriorly, their exact spacing and number not determined.

Discussion.—The description of *Bipulvina croftsae* is based on three steinkerns preserved in chert. The first is incomplete and rather poor, and shows only the lines of muscle scars and paralleling depressions. These depressions are represented as ridges above, or dorsal, to the muscles. The second steinkern shows the shape well, but does not preserve many details. The third is incomplete but exceedingly well preserved; it is on this specimen that most details of the anterior were seen.

Five sets of paired muscle scars are on the main body of the steinkern. They are limited to the flattened area set off from the anterior and posterior slopes. The scars are all high on the sides, stand in relief, and appear to be relatively large and deep compared to the scars of other monoplacophorans. They indicate a fairly thick shell, as thin shells of patelliform mollusks commonly either lack muscle scars or have them poorly developed. The flaring at the margin of the steinkerns is another indication of a relatively thick shell. Secondary deposits may have further augmented the shell thickness and may be the cause of the flattening of the dorsum as they are in *Tryblidium reticulatum* Lindström (Knight, 1941, p. 364).

The markings on the anterior slope are all fainter than those posteriorly and are of a different shape. They are more the ridge and depression type seen in *Proplina cornutaformis* (Walcott), though of course much smaller. Two sets can be seen clearly; the one just posterior to the apex is so faint it might be interpreted differently by another observer. Whatever their exact number and position, these markings on the anterior of the steinkern indicate a differentiated head region, and suggest a fairly complex musculature.

In contrast to these faint markings on the anterior slope, the constriction at the apex is quite clear. It is seen on two steinkerns as a depressed and flattened subtriangular area on each side of apex. This depression may connect with the lowest shallow depression just posterior to it. Anterior to the constriction, the apex of one steinkern is bifurcated. This bifurcation suggests the presence of a short median septum in the shell. An alternative explanation, which cannot be checked until further specimens are obtained, is that the apex of the shell was not completely filled with chert before the shell was dissolved.

On the anterior lateral slopes just above the line where the steinkern flares out to the margin and just anterior to the first large muscle scar, paired elongate ridges are quite clear. The are present as sharp depressions in the steinkern. Other depressions, much shallower, but of similar size and shape occur posteriorly on the lateral and posterior slopes. Their spacing is not clearly evident, but does not appear to be uniform. The anterior markings and those on the lateral slopes may not necessarily have had the same function. No satisfactory interpretation of these markings can be given. Whatever they may be, they are not the same as the "shadow scars" in *Archaeophiala* Perner (Knight, 1952, p. 27), as these "scars" would be represented on the steinkern by ridges rather than depressions and would be in a different position with reference to the muscles.

Locality.—U.S.G.S. locality 237y (green), Cambrian-Ordovician register. On Poverty Flat, NW¼NE¼ sec. 31, T. 37 N., R. 1 W., Washington County, Mo. The Poverty Flat lead workings were mined in 1890–1891. Mr. Koenig indicates that they are on the northwest of a dirt road, just south of a sharp bend, clearly shown on the Berryman, Missouri, quadrangle sheet. The specimens were collected by J. D. Robertson, of the Missouri Geological Survey, in 1890 or earlier. The register, written June 3, 1933, or later lists the specimens as being from the Gasconade dolomite.

Catalogued specimens.—U.S.N.M. no. 135184; paratypes U.S.N.M. nos. 135185 a, 135185 b.

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POST-SHOT YIELD MEASUREMENT OF AEC UNDERGROUND NUCLEAR TEST

The Atomic Energy Commission has reported the resultant yield of the deep underground nuclear test conducted at the AEC Nevada Test Site in September 1957 as 1.7 kilotons.

The shot was detonated at 09 hours 59 minutes 59.45 seconds Pacific Daylight Time (16:59:59.45 GCT) on September 19, 1957, at the end of a tunnel about 2,000 feet long dug horizontally into the side of a mesa at the northern edge of the Yucca Basin. The explosion took place in a layer of volcanic tuff. The coordinates of the detonation point are: latitude 37°11′44.8″, longitude 116°12′11.3″, elevation 6,615 feet above mean sea level. The vertical distance from the detonation point to the mesa surface is 899 feet, and the slant distance to the side of the mesa is approximately 800 feet.

Post-shot investigation of the tunnel and surrounding area confirms that the explosion was contained and that no radioactive materials escaped into the surrounding air. A detailed study of the area and the local effects of the detonation is in progress.

PALEONTOLOGY.—Hedbergella, *a new name for a Cretaceous planktonic foraminiferal genus.* PAUL BRÖNNIMANN, Esso Standard Oil, S. A., Habana, AND NOEL K. BROWN, JR., Gulf Oil Corporation, New York. (Communicated by H. A. Rehder.)

(Received August 21, 1957)

The generic name *Hedbergina* was introduced by Brönnimann and Brown (1956, p. 529) for a group of planktonic Foraminifera ranging in age from Aptian or Albian to Cenomanian. *Globigerina seminolensis* Harlton was thought to be representative of this group and was originally designated the type species of *Hedbergina*. Although Harlton's figures of the holotype of *G. seminolensis* (1927, pl. 5, fig. 7a, b) seem to give a true likeness of the group, later examination of this specimen at the U. S. National Museum has shown that it is not typical of the group for which Brönnimann and Brown (idem, pp. 529, 530) intended their name *Hedbergina* to represent. The holotype is so unlike Harlton's deceptive figures that it may not even be the specimen which he originally figured. The holotype does in fact, as noted previously by Plummer (1945, p. 264), resemble quite closely *Globigerina cretacea* d'Orbigny. It has a relatively large umbilicus and may have possessed an umbilical cover-plate which was later broken away.

Harlton (idem, p. 25) originally stated that the type locality of *G. seminolensis* was the Pennsylvanian Glenn formation, about 4 miles north of Ardmore, Carter County, Okla. However, Tomlinson (1929, p. 78) questioned the correctness of this and other localities supplied by Harlton. Later Harlton (1929, p. 308) admitted these errors but did not completely rectify them. Plummer (idem, p. 264), who examined the holotype of *G. seminolensis* was of the opinion that it was not "a convincing Pennsylvanian faunal member." Inasmuch as Comanchean (Aptian to Cenomanian) strata crop out in and around the town of Ardmore, Brönnimann and Brown (idem, p. 530) believed Harlton's species to be a Comanchean form. We now believe, judging from the morphology of the holotype, that *G. seminolensis* is a younger Cretaceous fossil.

In spite of our intention, *G. seminolensis*, represented by its holotype as this specimen is now known to be, was originally, though inadvertently, designated the type species of *Hedbergina*; and for this reason the designation is binding and must be followed. Although our definition of *Hedbergina* is now known not to refer to *Hedbergina*, it still applies to the group of fossils for which that name was unfortunately introduced, and for which we now propose the new name *Hedbergella*. The definition of *Hedbergella*, n. name, which is the same as that previously given by Brönnimann and Brown (idem, p. 529) for *Hedbergina*, is as follows:

> The smooth- to rough-walled, calcareous hyaline test is trochospirally coiled. Its small early chambers are globular, inflated, and globigerine-like. The last few chambers are elongated and extend into a relatively small umbilicus. The aperture is rounded, interiomarginal, and opens into the umbilicus. Short apertural flaps extend into the umbilicus but do not form an umbilical cover-plate.

Remarks.—The most characteristic feature of *Hedbergella*, n. name, is the extension of the last few chambers into the umbilicus. This represents a stage in the phylogeny from a *Globigerina*-like form with a tight umbilicus to *Ticinella* Reichel with a large umbilicus and umbilical cover-plate. In this lineage the enlarging umbilicus was at first minimized by extension of the last few chambers as a whole into it as represented by *Hedbergella*. Later in the lineage the umbilicus became too large to be filled in by the chambers themselves. However, by extending only the apertural flaps, and not the chambers as a whole, the large umbilicus was covered by an umbilical cover-plate composed of extended apertural flaps as represented by *Ticinella*.

Reichel (1950, pp. 601–603), Hagn (1952, pp. 769, 770; 1955, pl. 22, fig. 2, pl. 23, fig. 1), and Umiker (1952, pl. 5, fig. 2, Pv; pl. 6, fig. 3, Pv) have referred forms belonging to *Hedbergella*, n. name, to the genus *Pseudovalvulineria* Brotzen (type species: *Rosalina lorneiana* d'Orbigny), but *Hedbergella*, n. name, differs from this genus in possessing early globigerine-like chambers and a rounded aperture.

Globigerina infracretacea Glaessner seems to belong to the genus *Hedbergella*, but this is not easily ascertained since Glaessner (1937, p. 28, text-fig. 1) only figured dorsal and peripheral views of his species. However, Subbotina (1953, pl. 1, figs. 5–10) has presented excellent figures of specimens of *G. infracretacea*. In the ventral views of her figures the chambers themselves are seen to extend into the umbilicus, thus indicating that *G. infracretacea* should be allocated to *Hedbergella*.

"*Anomalina* sp. aff. *lorneyana* (d'Orb.) typ." of Montanaro Gallitelli (1947, p. 194, text-fig. 1, no. 18a, b) is either a *Hedbergella* or *Ticinella*, but one cannot tell which since she did not figure a ventral view.

The type species of *Hedbergella*, n. name, is here designated *Anomalina lorneiana* var. *trocoidea* Gandolfi. This form is raised to the rank of species and described below as *Hedbergella trocoidea* (Gandolfi).

Hedbergella trocoidea (Gandolfi)
Fig. 1, a–c

1942. *Anomalina lorneiana* (not d'Orbigny) GANDOLFI, Riv. Ital. Paleont., anno **48**, mem. 4: p. 98, pl. 4, figs., 1, 19; pl. 8, fig. 2; pl. 13, figs. 1a, b, 4a, b.

1942. *Anomalina lorneiana* var. *trocoidea* GANDOLFI, idem, p. 99, pl. 2, fig. 1a–c; pl. 4, figs. 2, 3; pl. 13, figs. 2a, b, 5a, b.

1951. *Anomalina lorneiana* d'Orb. var. *trocoidea* Gandolfi, NOTH, Geol. Bundesanstalt, Jahrb., Sonderbd. **3:** 80, pl. 4, figs. 27a, b, 28a, b.

1952. *Pseudovalvulineria* sp., UMIKER, Univ. Bern, Geol. Inst., Diss., pl. 5, fig. 2(Pv); pl. 6, fig. 3(Pv).

1952. *Pseudovalvulineria trocoidea* (Gandolfi), HAGN, Erdöl und Kohle **5:** text-figs. 1 (part), 2 (part).

1955. *Pseudovalvulineria trocoidea* (Gandolfi), HAGN, Internat. Sedimentary Petrogr. Ser. **1:** pl. 22, fig. 2 (part); pl. 23, fig. 1 (part).

1956. *Hedbergina seminolensis* (not Harlton), BRÖNNIMANN and BROWN, Eclogae geol. Helv. **48:** 592, pl. 20, figs. 4–6.

Not *Globigerina seminolensis* HARLTON, 1927, Journ. Pal. **1:** p. 24, pl. 5, fig. 7a, b.

Description.—The rather rough-walled, coarsely granular test is low to relatively high trochospirally coiled. Its early chambers are small and globigerine-like. The last whorl is composed of six to eight chambers, the last one or two of which are markedly elongated and extended into a tight umbilicus. The interiomarginal aperture is rounded and opens into the umbilicus. It is bordered by a short apertural flap.—Brönnimann and Brown's (idem, p. 529) description of *Hedbergina seminolensis* (not Harlton).

FIG. 1.—*Hedbergella trocoidea* (Gandolfi). Lectotype of *Anomalina lorneiana* var. *trocoidea* Gandolfi. *a*, dorsal view; *b*, peripheral view; *c*, ventral view. ×50. After Gandolfi (1942, pl. 2, fig. 1a–c).

Remarks. — *Anomalina lorneiana* (not d'Orbigny) of Gandolfi (1942, p. 98, pl. 4, figs. 1, 19; pl. 8, fig. 2; pl. 13, figs. 1a, b, 4a, b) is a low-spired form, and *A. lorneiana* var. *trocoidea* Gandolfi is a high-spired form. Such forms seem to represent extremes in the variability of the species. Both forms are included in the same species herein called *Hedbergella trocoidea* (Gandolfi). *Globigerina infracretacea* Glaessner can probably be referred to *Hedbergella*, but it is smaller, though relatively stouter, its walls are smoother, and it possesses fewer chambers in the last whorl than *H. trocoidea*.

Placentula nitida (not Reuss) of Berthelin (1880, p. 69, pl. 27, 4, fig. 11a–c) from the Albian of Montcley, Department of Doubs, France, appears to be a similar form, as noted by Gandolfi (idem, p. 99). However, Bartenstein (1954, p. 49), who restudied the Montcley material, places Berthelin's form in synonymy with *Valvulineria parva* Khan, which is unlike any *Hedbergella*. *Discorbina galiciana* Friedberg, originally described from beds of supposedly Senonian age near Lwów

(Lemberg) in the Ukraine (formerly southeastern Poland), may also represent a *Hedbergella*.

In raising the rank of this form from variety to species, we have retained Gandolfi's varietal name as the specific name. In Gandolfi's paper the spelling of this name where printer's type was used is "*trocoidea*" (idem, p. 99, explanations to pls. 2, 13). His spelling of the name where drafted letters were used is "*trochoidea*" (idem, text-fig. 49, pl. 4). Although "*trocoidea*" is probably the intended spelling, this is not certain. According to the Copenhagen Decisions on Zoological Nomenclature (Hemming, ed., 1953, pp. 43–44), "Where there was more than one Original Spelling and in the case of none of these spellings was there clear evidence that it was the result of an inadvertent error, the *Valid Original Spelling* is that one of the Original Spellings used by the *First Subsequent User* of the name." Reichel (idem, pp. 601, 603) appears to have been the first user (other than nomenclators, e.g., the *Zoölogical Record*, Thalmann's *Indexes to new genera, species and varieties of Foraminifera*, and Ellis and Messina's *Catalogue of Foraminifera*) of Gandolfi's name, but he also used the two spellings. Noth (1951, p. 80) was the next user of Gandolfi's name which he spelled "*trocoidea*." We regard Noth's usage as the valid spelling.

No holotype of *Anomalina lorneiana* var. *trocoidea* was originally designated or indicated by Gandolfi. The specimen Gandolfi (idem, pl. 2, fig. 1a–c) illustrated as "*Anomalina lorneiana* d'Orbigny *trocoidea* n. var. Breggia, strato 14, 50×." is herein designated lectotype. Gandolfi's original figure of this specimen is reproduced here as Fig. 1*a–c*.

The lectotype of "*Anomalina lorneiana* var. *trocoidea* Gandolfi" is deposited in the collections of the Institute of Geology and Paleontology, University of Basel, Switzerland.

The type locality of *Hedbergella trocoidea* (Gandolfi) is the lower part of the *Scaglia variegata* (Aptian or Albian), bed 14, about 35 m above the top of the Barremian Biancone limestone, in the gorge of Breggia River, northeast of Balerna, near Chiasso, Canton Ticino, southeastern Switzerland.

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ENTOMOLOGY.—*Venomous moths and butterflies.*

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(Received September 24, 1957)

LARVAE WITH VENOMOUS HAIRS OR SETAE

The larvae of a number of species of moths and butterflies are known to bear venomous hairs or setae. The following may be mentioned:

Lagoa rispata (fam. Megalopygidae). This is a common eastern species, the caterpillars feeding upon the leaves of oak, elm, apple, raspberry, and various shrubs. These are fleshy and furnished with a dense coat of long, silky, brown hairs which project upward and meet to form a ridge or crest along the median dorsal line. Among these fine hairs venomous setae occur.

Sabine stimulea (fam. Limacodidae, by some authors termed the Cochlidiidae and by others the Eucleidae). These are known as the slug-caterpillar moths. *Sabine stimulea* is the saddle-back caterpillar, feeding on oaks and other forest trees. The larva is characterized by a green patch on the back resembling a saddlecloth, the saddle being represented by an oval purplish brown sopt. The moth is dark reddish brown in color with two white dots near the apex of the fore wings.

The spiny oak slug (*Euclea delphinii*) is another common species feeding on oak, pear, willow, and other trees.

Automeris io (fam. Saturniidae) (Giant silkworms). This is called the io-moth and is a common species in the eastern part of the United States. It is characterized by large conspicuous eye spots on the hind wings. The larvae, armed with particularly venomous spines arranged in tufts, are green, with a broad brown or reddish-white edged stripe on either side of the abdomen, and the spines are tipped with black. This is a common species, and the junior author, in his boyhood, was well acquainted with this caterpillar and often deliberately touched the spines of the caterpillars against the tender skin of the arms or fingers to note the venomous reactions. Frequently, too, he sometimes inadvertently came in contact with them, usually while cutting or shocking corn, and was at once made aware of their presence by a burning sensation followed by more or less temporary redness or swelling.

The maia-moth, *Hemileuca maia*, is also a member of the same family Saturniidae. It is the only species of the genus in the eastern United States and is not particularly common. The larvae feed upon the leaves of the oak, are brownish black with a lateral yellow stripe, and each segment is armed with large, branching, venomous spines.

Browntail moth, *Euproctis chrysorrhoea* (fam. Lymantriidae, or Lipariidae). The tussock moths. This is a European pest introduced first into Massachusetts at some unknown date, but in 1897 its ravages came to notice, and the species since has spread over much of New England, and into Nova Scotia, New Brunswick, and other areas. The larvae are more or less social in behavior, fastening leaves together with silk as shelters in which they pass the winter. They are nearly black in general coloration, and are clothed with brownish, barbed hairs, borne on the subdorsal and lateral tubercles. These hairs are venomous and in contact with the human skin, produce an inflammation similar to that of poison ivy. Even the cast spines of the larvae are readily blown about by the wind, the venomous hairs causing much discomfort.

ADULT INSECTS WITH VENOMOUS HAIRS OR SETAE

It is perhaps less generally known that the hairs or setae of the adult moths and butterflies, in some parts of the world, may also produce great discomfort, as troublesome irritations or inflammation in contact with the skin of tender areas of the human body. In this country the hairs of the adult insects of the browntail moth are known to be of this character.

In some parts of the world, especially in

the warmer regions of South America, the presence of moths with venomous hairs may at times constitute a serious health problem.

The following observations and account of the senior author, living at Tingo María, Peru, in the province of Huanaco, on the east slope of the Andes, in the tropical rainforest, may be of some interest to entomologists and to the medical fraternity as well.

In the Tingo María area, in 1952, during the latter part of April and the month of May, near the close of the season of heavy rains, great numbers of small, dusty black moths made their appearance, congregating about electric lights along the streets of Tingo María, and around those over the entrance of houses. In unscreened houses where lights were present these moths were attracted in numbers. These moths at Tingo María appear at about the same season every year, and in 1952, they became exceptionally numerous, together with a number of other species, but the dusty black species were dominant, appearing in enormous numbers. It was soon obvious that the irritations which soon developed were associated with this moth. Simultaneously with these hordes many people experienced a troublesome rash. Spotted red areas or small pimples or streaks developed on the inner angle of the forearm. Irritations also appeared on the neck or on other tender parts of the body. So general was the affliction that affected individuals visited the hospital at Tingo María, thinking they were affected with some new, strange tropical disease. It is estimated that 70–80 per cent of the population was affected, perhaps as many as several thousand people.

The senior writer suspected that the hairs of this ubiquitous moth were responsible for this rash and carried out a few texts which definitely proved that his surmise was correct. He caught several of the moths and gently rubbed them up and down the inner part of his own forearm and also made similar tests upon several Peruvian technicians at the Experimental Station who had not previously experienced the prevailing rash. In about 15–20 minutes all who had submitted to the test had broken out with a red, itching rash in the treated areas. Both the senior writer's garage and house at Tingo María were equipped with an electric light over the entrance doors. Every night hundreds of these moths were attracted to these lights.

This moth has an interesting behavior by playing possum when touched, at once lifting and closing its wings in an upright position over the body, then usually relaxing its hold upon the object to which it is clinging and simply falling to the ground as if helpless or dead. In a few seconds or a minute it appears to revive and crawl or fly away.

Although the great swarm of these moths appear in April and May, a few belated individuals may be seen in June, but very few in numbers in comparison with the great initial invasion.

The day following their nightly appearance, they remain around the light which attracted them, but many fall to the ground and appear to die and are carried away or eaten by ants. Their constant fluttering about the lights scatters great quantities of the hairlike fuzz dislodged from their bodies, and this forms a dense covering on all objects below or near the lights, and is blown about. This at once explained the occurrence of the rash each time the senior author worked in his workship in the garage, whenever he paused and rested his forearm on the work bench. On these occasions, always in a short time, the rash made its appearance, and the itching continued for several hours or more. At the height of the invasion of these moths, people were being constantly re-exposed each night so that the rash was aggravated into an almost chronic and distressing condition to be endured for several weeks.

Specimens of this moth, collected by the authors, have been kindly identified by William D. Field, associate curator of insects, U. S. National Museum, as a species of *Hylesia* close to *Hylesia volvex* Dyar, of the lepidopterous subfamily Hemileucinae, family Saturniidae. According to Mr. Field this troublesome genus presents great taxonomic difficulties so that the Tingo María species cannot at present be more definitely named, than a species near *Hylesia volvex* Dyar. Mr. Field has been of much assistance in the preparation of relevant litera-

ture discussing the moths of the genus *Hylesia*, and the skin irritations which they induce.

TESTS OF THE JUNIOR AUTHOR

Early in July the senior writer (my son) sent me six or seven dried specimens of this moth, and I made the following tests. I carefully rubbed the abdominal portion of a dry moth, bearing a coat of velvety dark hairs, on the skin of the bend of my forearm at or little below the elbow. This was done at 2 p.m. July 17. There was no noticeable immediate effect, but in about two hours, the area showed a noticeable redness and by nightfall the skin was hot and fiery red with a pronounced puffiness resembling weals, and itching had become intense. This discomfort persisted throughout the night. Even at nightfall of the next night, July 18, the redness, puffiness, and itching were very pronounced. By nightfall of July 19, a marked fiery redness was still evident, and tiny pimplelike blisters had appeared, with blood-red dots as if a slight haemorrhage had taken place at many pin-point spots. There was marked hyperaemia in the area, and the affected skin seemed hot and feverish, and appeared to perspire more freely than unaffected areas.

I purposely avoided any palliative treatment or medication with alcohol or other reagents, as I wished to learn how persistent this trouble would be. There was still some redness of my forearm on July 22, but there was now little swelling, and with only occasional periods of itching, and this became most noticeable only following work or exercise during periods of hot weather. By July 24, all irritating symptoms resulting from the test had completely subsided. The irritations induced had therefore lasted almost one week, or at least for six days, although some redness remained for a few days longer.

In the literature there are a number of reports of skin irritations produced by species of moths of the genus *Hylesia*.

In the Lima newspaper *La Cronica*, May 12, 1952, the following translated account appeared.

> Montevideo, 12 (U/P/).—The crew of the Italian oil-tanker *Unitas* who were detained in quarantine some days after arriving from Carit pito, Venezuela, due to a fear of an epidemic of a dangerous tropical disease, stated that while taking on oil in Venezuela, actual clouds of yellow-tailed butterflies alighted on the hands, faces and other exposed parts of the officers and sailors, which they crushed with their hands or other objects. A few hours before the ship weighed anchor, the crew showed symptoms of a curious disease. The skin was irritated first, followed later by a painful inflammation. The captain, Romulo Ballestrino, radioed the Institute of Tropical Diseases in Rome, where a correct diagnosis was made and an efficient remedy prescribed.

If this account is correct in all its features, it is evident that even certain swallowtail butterflies of the genus *Papilio* may cause troublesome skin inflammations similar to that caused by the moths of the genus *Hylesia*, but this needs further confirmation. Little work appears to have been done to determine the exact nature of the skin irritations produced by the hairy covering of the moths of the genus *Hylesia*.

Mr. Leger and P. Mouzels (see reference 4) appear to have made a more than cursory study of the character of the irritations produced.

They examined microscopically the individual hairs or setae of the body covering of the moths of *Hylesia*, a species appearing at Cayenne in French Guiana in July and August at the close of the rainy season, causing skin eruptions, watery blisters and inflammation, especially in young children. The natives are familiar with its cause, ascribing it to *Mauvais papillons*. The trouble occurs only during a short period when certain moths of the genus *Hylesia* appear, and usually persists for only about eight days. They examined microscopically the hairs and setae of the body covering of these moths and found three sorts. Most of these were 140–150 microns long with the largest diameter of 3 microns. These apically were sharp-pointed, and some were furnished with downwardly directed barbs. Others were larger, up to 300 microns long, and less sharply pointed. Some are lance-shaped, shaped something like a knife. Some are plates 2 microns thick with a length 120–150 microns.

Leger and Mouzels very convincingly proved that the irritations produced by the

hairs of these moths were not of merely mechanical origin. After macerating the moths, some in alcohol, and some in water, these two solutions were centrifuged to eliminate all scales and hairs. The solutions were now separately tested on the tender skin. The alcohol solution was absolutely without effect. The water solution, after 4 hours, produced the typical characteristic irritations of *Hylesia*, which persisted for four to five days. This simple test indicated an irritating principle of chemical origin, comparable, it would appear, to the contact poisons of the sap of certain plants (*Rhus*).

In the June 1952 issue of the publication *The Lamp* (*7*), there appeared a most interesting account of insufferable irritations that workers on oil tankers visiting northern South America have experienced following visitations of the moths *Hylesia*. An artist's concept of swarms of these moths visiting one of these tankers attracted by the lights on board, is presented in an illustration. This is a most readable and popular account of the annoyances swarms of these venomous moths sometimes inflict upon the crews with their venomous hairs.

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(7) ANON. *Beware butterflies.* The Lamp (2) 20–21. June 1952. [An excellent and vivid account of violent skin irritations induced upon the exposed skin of workers on oil tankers of the Standard Oil Co. (New Jersey) in the Gulf of Paria, northern South America.]

THE STATUE OF NEWTON AT CAMBRIDGE

Newton with his prism and silent face,
The marble index of a mind for ever
Voyaging through strange seas of Thought, alone.

—WORDSWORTH.

ENTOMOLOGY.—*A recharacterization of the genus* Coelopencyrtus, *with descriptions of two new species (Hymenoptera: Encyrtidae).* B. D. BURKS, Entomology Research Division, U. S. Department of Agriculture. (Communicated by C. F. W. Muesebeck.)

(Received September 9, 1957)

In 1919 Timberlake (Proc. Hawaiian Ent. Soc. **4:** 218–225) described two genera of Encyrtidae for species which are parasitic on the mature larvae of aculeate Hymenoptera in Hawaii. *Coelopencyrtus* was described for *odyneri* Timberlake and *swezeyi* Timberlake, both reared from the mature larvae of the vespid wasp *Odynerus nigripennis* (Holmgren), and *Nesencyrtus* was described for *Adelencyrtus kaalae* Ashmead, reared from the mature larvae of the colletid bee *Nesoprosopis pubescens* Perkins.

Coelopencyrtus was characterized as having the female antenna with the basal funicle segments at least as long as broad, the funicle considerably longer than the club, the club itself not greatly wider than the funicle, the mouth opening not greatly widened, the thorax elevated, and the ovipositor not exserted; the male had simple antennae and the head had the frons protuberantly produced beyond the eyes. *Nesencyrtus*, contrariwise, had the female antennal funicle with all segments broader than long, the club almost as long as the entire funicle and much broader than it, the mouth opening very broad to accommodate the unusually large mandibles, the thorax somewhat depressed, and the ovipositor slightly exserted; the male had ramose antennae and the frons was not protuberantly produced beyond the eyes.

Shortly after his 1919 paper, Timberlake described two more species of *Coelopencyrtus*. *C. orbi* (1920, Proc. Hawaiian Ent. Soc. **4:** 422) was a parasite of the mature larvae of *Odynerus orbus* Perkins, and *mauiensis* (1922, ibid. **5:** 137) like *odyneri* and *swezeyi*, was a parasite of the mature larvae of *Odynerus nigripennis* (Holmgren). He also described a second species of *Nesencyrtus*, *sexramosus*, from a single unreared male specimen (1922, ibid. **5:** 141). All these species are Hawaiian. No additional species in either genus have been described up to now.

Recently two species of encyrtid parasites of mature larvae of the solitary colletid bee *Hylaeus* were reared and submitted to me for identification. One species had been reared in Utah and the other on Plummers Island, Md. It was apparent that these species were undescribed, but their generic assignment presented considerable difficulty. They could not be placed to genus with published keys, such as those of Ashmead (1904, Mem. Carnegie Mus. **1:** 286–311), Mercet (1921, Fauna Ibérica, Himenópteros, fam. Encírtidos, pp. 60–82), Ferrière (1953, Mitt. Schweiz. Ent. Ges. **26:** 1–45), or Erdös and Novicky (1955, Beitr. zur Ent. **5:** 165–202). In Ashmead or Mercet they ran out near *Epiencyrtus*, but even a casual examination of these *Hylaeus* parasites showed them not to be that genus. Consequently a search was made through the numerous described encyrtid genera which are not included in the published keys. Fortunately specimens of many of these genera are in the U. S. National Museum collection. A study of these specimens and the literature finally made it clear that the *Hylaeus* parasites had a blend of the characters of Timberlake's genera *Coelopencyrtus* and *Nesencyrtus*. The males have simple, nonramose antennae, as in *Coelopencyrtus*, but the heads are nonprotuberant, as in *Nesencyrtus*. The females have the funicle segments all broader than long, the club large and wider than any funicle segments, the thorax depressed, and the ovipositor exserted, as in *Nesencyrtus*, but the mouth opening is relatively narrow, as in *Coelopencyrtus*.

Under these circumstances it seemed advisable to re-study all the species which have been placed in *Coelopencyrtus* and *Nesencyrtus*, to see how distinct they are generically. A re-examination of Timberlake's excellent descriptions and figures, along with a study of type material of *N. kaalae* and *C. odyneri*, *swezeyi*, and *orbi* in the U. S. National Museum collection, have led to

the conclusion that they all represent a single genus. The rami of the funicle segments of the male antennae are not generically significant, as these vary from six funicular rami in *sexramosus*, to four in *kaalae*, to three small rami in *mauiensis*, to one large ramus in *swezeyi*, to one very small ramus in *odyneri*, to none in *orbi*. In *orbi*, however, there is a small, ramuslike projection on the pedicel of the male antenna. Somewhat similar projections are present on the pedicels in *swezeyi* and *mauiensis*, while the pedicels are simple or only very slightly modified in *sexramosus*, *kaalae*, and *odyneri*. As for the female characters, *orbi* comes very close to bridging the separation between *Coelopencyrtus* and *Nesencyrtus*. *C. orbi* has all the funicle segments broader than long, the club is three-fourths as long as the entire funicle, the mouth opening is broader than in *odyneri*, but not so broad as in *kaalae*, the thorax is somewhat depressed, and the ovipositor is exserted, less so than in *kaalae*, but much more so than in *odyneri*. The protuberant head, so striking in the male of *odyneri*, is present in a reduced degree in the males of *orbi* and *mauiensis*.

Consideration of these facts justifies the conclusion that all the species mentioned above, as well as the two to be described below, belong in one genus, despite the striking differences that exist between some of the species. The name *Coelopencyrtus* has page priority. It may be mentioned parenthetically that the genus *Giraultella* Gahan and Fagan (=*Epaenasomyia* Girault 1919, not 1917), parasitic on the larvae of the xylocopid bee, *Xylocopa*, in Java is probably not the same as *Coelopencyrtus* although seemingly closely related. *Giraultella* is very inadequately described, and I have seen no authentic specimens. Its description was published one month after *Coelopencyrtus*.

Genus **Coelopencyrtus** Timberlake

"*Ageniaspis* sp.," Swezey, 1907, Ent. Bul. Hawaiian Sugar Planters Assoc. Expt. Sta. **5:** 52.

Coelopencyrtus Timberlake, 1919, Proc. Hawiian Ent. Soc. **4:** 218; Timberlake, 1922, ibid **5:** 135. (Type: *Coelopencyrtus odyneri* Timberlake, by original designation.)

Nesencyrtus Timberlake, 1919, Proc. Hawaiian Ent. Soc. **4:** 223. (New synonymy.) (Type: *Adelencyrtus kaalae* Ashmead, by monotypy and original designation.)

Description.—Mandible with three teeth; maxillary palp with four segments, apical one the longest; labial palp with two segments, apical one the shorter; antennae inserted low on frons, near the mouth border, a relatively broad, rounded projection present between antennal bases; antennal scape enlarged, but not lamelliform; funicle with six segments, most or all of which are wider than long; club clearly 3-segmented and large, varying in length from three-quarters as long as to as long as entire funicle, and in width varying from only slightly wider than to greatly wider than broadest funicle segment; width of malar space varying from three-fifths to nine-tenths as great as maximum diameter of a compound eye; fronto-vertex broad, separated from face by a broadly rounded or subacute angle, surface faintly reticulated and lacking alveolar punctures; lateral ocelli almost touching eye margins. Thoracic notum slightly to moderately depressed, mesoscutum and scutellum shining, smooth or very minutely and faintly reticulated; axillae almost but not quite meeting on meson; scutellum without a pencil of hairs or lamelliform bristles; brachypterous or apterous forms unknown; wings long, their apices greatly exceeding gaster; submarginal vein of forewing without an apical, triangular enlargement; marginal vein as long as wide, stigmal vein arising from marginal and as long as marginal and postmarginal veins combined; marginal cilia of forewing very short and dense; legs with femora and tibiae flattened, but lateral margins not carinate; mid tibial spur as long as first mid tarsal segment. Propodeum extremely short on meson, spiracles separated from anterior propodeal margin by a space nearly equal to diameter of a spiracle; gaster slightly wider than thorax and varying from three-quarters to nine-tenths as long as thorax; tips of ovipositor sheaths hidden or slightly exserted. Male with antennal pedicel and funicle varying from simple to more or less ramose, club solid; head more or less protuberantly produced forward beyond eyes dorsally.

Members of this genus are parasites of the mature larvae of nest-building aculeate Hymenoptera. The hosts nest in wood (in twigs, abandoned beetle burrows, or in rotten logs), or in clay cells; none has been reared from ground-nesting Aculeata. The host larva becomes greatly distended and filled with cells, much like lepidopterous larvae parasitized by *Copidosoma* (*see* Timberlake, 1919, loc. cit., p. 220).

Coelopencyrtus kaalae (Ashmead), n. comb.

Adelencyrtus kaalae Ashmead, 1901, Fauna Hawaiiensis **1**, pt. 3: 323.

Nesencyrtus kaalae (Ashmead) Timberlake, 1919, Proc. Hawaiian Ent. Soc. **4**: 183, 214.—Timberlake, 1922, ibid. **5**: 139.

Coelopencyrtus sexramosus (Timberlake), n. comb.

Nesencyrtus sexramosus Timberlake, 1922, Proc. Hawaiian Ent. Soc. **5**: 141.

Coelopencyrtus hylaeoleter, n. sp.

Female.—Length 1.0–1.25 mm. Head and thorax dark brown to almost black, with a very faint metallic blue luster visible under strong light; antennae dark brown, with apex of pedicel tan; wings hyaline, veins dark brown, forewing with a short, faint, brown streak at base and a small brown stain below marginal vein; legs dark brown, with trochanters, tibial spurs, and basal tarsal segments tan or yellow; gaster brown, with a broad, dark brown stripe across the middle.

Mandible, Fig. 3, with dorsal tooth blunt, ventral two teeth acute. Head in anterior aspect broader than long. Antennae inserted low on frons near mouth border; scape, Fig. 2, enlarged in the middle, its maximum width one-third as great as its length; pedicel semiglobose, two-fifths as long as scape; funicle segments all wider than long, first and second segments each slightly longer than third or fourth, fifth and sixth segments longest; club broader than any funicle segment and almost as long as entire funicle. Malar space long, its width three-fifths as great as maximum diameter of compound eye. Surface of fronto-vertex minutely reticulated, mat, clothed with numerous microbristles; eyes bare. Ocelli forming a right angle; lateral ocellus very close to margin of compound eye, length of ocellocular line one-half as great as diameter of lateral ocellus and one-sixth as great as length of postocellar line.

Thorax minutely reticulated dorsally, subshining, and clothed with microbristles; dorsal surface of thorax flattened, almost plane medially; pronotum narrower than mesonotum; scutellum and mesoscutum equal in length on meson. Forewing greatly exceeding apex of gaster; marginal vein thickened, Fig. 1, equal in length to postmarginal vein and three-fourths as long as stigmal vein; hairless streak narrow; marginal cilia extremely short. Basal tarsal segment of mid and hind leg as long as tarsal segments 2 and 3 combined, basal fore tarsal segment slightly shorter than segments 2 and 3.

Propodeum extremely short on meson, posterior and anterior margins almost in contact; propodeal spiracles round, separated from anterior propodeal margin by a space slightly longer than diameter of a spiracle. Gaster slightly broader and shorter than thorax; cerci located halfway between base and apex of gaster, each cercus bearing two long and one shorter bristles; ovipositor exserted for a distance one-fifth to one-fourth the length of the gaster.

Male.—Length 1.0–1.1 mm. Color, sculpture, and pubescence as in female. Antenna with scape one-half as wide as long, pedicel one-half as long as scape and as long as combined first and second funicle segments; third and fourth funicle segments slightly shorter than first or second, fifth and sixth slightly longer; club as long as two apical funicle segments. Thorax as in female. Gaster five-sevenths as long as thorax. Aedeagus normally protruding as far as female ovipositor is exserted, apex slender and down curved.

Type locality.—Logan Canyon, Utah.

Types.—U.S.N.M. no. 63570.

Described from 9 female and 4 male specimens, as follows: Type ♀, allotype ♂, and 7 ♀ and 2 ♂ paratypes, Logan Canyon, Utah, April, 1948, reared from mature larvae of *Hylaeus* sp., G. E. Bohart; 1 ♀ and 1 ♂ paratypes, North Logan, Utah, June 4, 1952, reared from mature larvae of *Hylaeus* sp. occupying old nest of *Sceliphron* sp., G. E. Bohart and M. D. Levin. All specimens deposited in the U. S. National Museum collection. Additional, more or less fragmentary, specimens which bear the same data as above are preserved in alcohol and on slides; these specimens are not included in the type series.

Coelopencyrtus hylaeoleter agrees with *C. orbi* Timberlake in having the funicle segments of the female all wider than long, with the club large; the eyes are bare in both species, and in both *hylaeoleter* and *orbi* the ocelli form a right angle, the head is wider than long, there is a short, brown streak in the forewing along the posterior margin near the base, and the tip of the ovipositor is exserted.

C. hylaeoleter differs from *orbi* in that the antennal club of the female is almost as long as the funicle in *hylaeoleter*, while this is only three-

fourths as long in *orbi*; in *hylaeoleter* the forewing is hyaline basally, with a small, brown-shaded area beneath the marginal vein, but in *orbi* the forewing is stained brown over the entire basal half, but lacks brown shading below the marginal vein; the apex of the ovipositor in *hylaeoleter* is exserted for a distance as great as one-fifth to one-fourth the length of the gaster, while in *orbi* the ovipositor is exserted for a distance only as great as one-tenth the length of the gaster. The male of *hylaeoleter* is at once distinguished from the male of *orbi* by its simple, unmodified antennal pedicel; the pedicel in *orbi* bears a prominent, conical projection laterally.

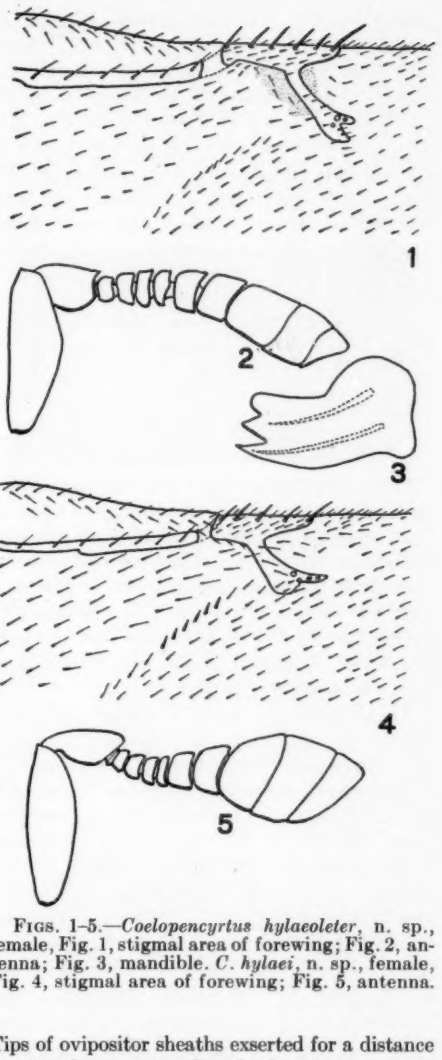
Coelopencyrtus hylaei, n. sp.

Female.—Length 1.0–1.1 mm. Head, body, and legs entirely black, with only the mid tibial spurs tan or yellow. Head with faint, metallic blue-green or dark purple luster under strong light; mesoscutum faintly metallic blue-green, scutellum nonmetallic. Wings hyaline, venation black; a very faint brown streak present along posterior margin at base of forewing; no dark shading or staining present in basal half or below marginal vein.

Head in anterior aspect slightly broader than long. Mandible as in *hylaeoleter*. Antenna, Fig. 5, very strongly clavate, third and fourth funicle segments extremely short; club as long as funicle and almost twice as wide as sixth funicle segment. Width of malar space two-thirds as great as maximum diameter of eye. Surface of frontovertex minutely reticulated, mat; eyes bare. Ocelli forming an angle of approximately 75°; lateral ocellus extremely close to lateral margin of eye, length of ocellocular line one-third as great as diameter of lateral ocellus and one-fifth as great as length of postocellar line.

Thorax dorsally minutely reticulated, only very faintly shining, almost mat; microbristles slightly more conspicuous than in *hylaeoleter*; thorax nor so flat dorsally as in *hylaeoleter*, the mesoscutum being more nearly arched and the scutellum only very slightly depressed on the meson; mesoscutum slightly longer than scutellum at median line. Forewing, Fig. 4, with marginal and stigmal veins relatively shorter than in *hylaeoleter* and a row of five or six microbristles in outer margin of hairless streak; legs as in *hylaeoleter*.

Gaster only very slightly wider than thorax and nine-tenths as long as it; cerci as in *hylaeoleter*.



FIGS. 1–5.—*Coelopencyrtus hylaeoleter*, n. sp., female, Fig. 1, stigmal area of forewing; Fig. 2, antenna; Fig. 3, mandible. *C. hylaei*, n. sp., female, Fig. 4, stigmal area of forewing; Fig. 5, antenna.

Tips of ovipositor sheaths exserted for a distance one-fourth as great as length of gaster.

Male.—Length 1.0 mm. Antenna with all funicle segments subequal in length; club as long as apical two funicle segments; gaster three-fourths as long as thorax; apex of aedeagus exserted and very slightly down curved.

Type locality.—Plummers Island, Md.

Types.—U.S.N.M. no. 63571.

Described from 22 ♀ and 1 ♂ specimens, as follows: Type ♀, Plummers Island, Md., taken dead from trap nest cell of *Hylaeus* sp., H-73,

August 14, 1956, K. V. Krombein; allotype ♂ and 21 ♀ paratypes, progeny of the type, taken alive from the same *Hylaeus* cell, August 17, 1956, K. V. Krombein. All specimens deposited in the U. S. National Museum collection. Mr. Krombein informed me that he first observed the original female specimen resting on the inner side of the septum of a *Hylaeus* cell in a trap nest on July 18, at which time the host egg apparently had not yet hatched. On July 20 the *Hylaeus* larva was observed to be partly grown and feeding; the chalcid still was resting on the septum. On July 27 the host larva was mature, its food had been consumed, and the chalcid had moved to the bottom of the cell. On August 14 the chalcid was dead in the cell, and the host larva was greatly distended, its body being completely filled with cells made by the developing chalcids, which were, by this date, darkened pupae. On August 17, the chalcids had emerged and were removed from the *Hylaeus* cell. There were 25 ♀ and 1 ♂ specimens, 3 ♀ of which were mutilated in opening the cell.

C. hylaei is closely related to *hylaeoleter*, described above, but can most easily be distinguished from it by its completely black coloration. The antennae, also, are different in the two species, as is shown in Figs. 2 and 5.

STUDY OF FROGFISHES

There are fishes that fish with "fishing poles," use "worms" for bait, can swallow other fishes as large as themselves, change color like chameleons, and inflate themselves a few times their normal size. These strange representatives of the class Pisces include some of the most fantastically hideous creatures in the world. One hardly would people an imaginary malevolent planet with creatures so weird in appearance.

These fishes are sparsely scattered through most of the tropical seas. For the most part they are bottom dwellers in relatively shallow inshore waters. Some hide in seaweed. The color of some species changes in accordance with the environment, but this is not universal in the family Antennariidae, or frogfishes, described by Dr. Leonard P. Schultz, Smithsonian Institution curator of fishes, in a U. S. National Museum publication recently issued. Several hitherto unknown species, including some of the most fantastic, from the Museum's collections were described.

There are several genera of "fish fishermen," but the family Antennariidae is easily the most fantastic and colorful. Appearance and ways of life differ greatly from one species to another but they all have, in general, certain characters in common. Each has a "fish pole," of varying length, at the end of its snout. This is a bony elongation of a dorsal spine. At the end of the "pole" are one to three fleshy projections, which look like marine worms and can be made to move like worms.

The fish lies motionless on the bottom or in a mass of seaweed. Another fish comes by and starts nibbling at the bait. The frogfish—so-called because of the general resemblance to frogs—just opens its mouth. The inflow of water sweeps the victim into the mouth. It usually happens too quickly for the eye to follow. The mouth can be greatly expanded, like that of a snake, to swallow a large victim.

The frogfish usually walks, rather than swims, Dr. Schultz says. The pectoral fins are modified to constitute legs of a sort. Movement is slow and clumsy. The frogfish way of life does not call for much agility, except with its big mouth. The ability to change color is probably more or less developed in all species of frogfishes, but in some much more than in others. This camouflage renders the creature almost completely invisible in a changing environment. Nearly every species can blow itself up either with air or water—usually with water—to a few times its normal size. This, Dr. Schultz believes, is probably a defense mechanism to terrify possible enemies.

One of the new genera described, with the name of *Kanazawaichthys* (in honor of Mr. Kanazawa of the National Museum staff) has thick bony plates on its head. Dr. Schultz believes that this is a creature of the deep open sea and that the plates serve in some way as a floating mechanism.

This family of fishes has been recognized for two centuries or more, but considerable confusion has existed among ichthyologists because of the secrecy of its ways of life. There are probably many species still unknown, says Dr. Schultz since the creatures are likely to be turned up mostly by accident.

ENTOMOLOGY.—*A new species of* Meropleon *Dyar from South Carolina (Lepidoptera: Noctuidae)*. E. L. Todd, Entomology Research Division, U. S. Department of Agriculture. (Communicated by A. B. Gurney.)

Two male specimens of a new species of *Meropleon* Dyar were recently discovered among specimens submitted for identification by Frances McAlister of Clemson Agricultural College, Clemson, S. C. The species is named and described as follows:

Meropleon titan, n. sp.

Proboscis somewhat abortive, coiled, well hidden by the labial palpi; palpi slightly upturned, reaching to about the middle of front, ventral margin of first and second segments fringed with loose hairlike scales, third segment small, clothed with appressed scales; front smooth, only slightly produced; eyes large, rounded; ocelli present, small; antennae bipectinate, gradually becoming simple at about apical one-fifth, the pectinations short, the pectinations of the inner margin longer than those of the external margin. Tegulae with outer margin clothed with black hairlike scales, a median spot of black-tipped scales at apical one-fourth. Vestiture of thorax mostly of long scales, many black-tipped, some tufts of long hairlike scales from above bases of hind wings. Abdomen rubbed (other species of the genus have a series of dorsal crests near the base). Forewing broad, triangular, apex slightly rounded, outer margin weakly angulate at Cu_1; R_1 from near middle of cell, R_3 from R_2 anastomosing with R_{4+5} to form areole; R_3 and R_4 shortly stalked; M_1 from lower margin of areole; M_2, M_3 and Cu_1 from near lower angle of cell, M_2 converging toward M_3 basally; Cu_2 from apical one-fourth of cell; upper discocellular absent. Hind wings with Sc + R_1 adnate with cell near base; Rs and M_1 shortly stalked from upper angle of cell; M_2 obsolescent, from well above lower angle of cell; M_3 and Cu_1 connate at lower angle of cell.

Forewing cinereous with rufous and fuscous scaling in the basal, medial and subterminal area; subbasal line represented by a short black mark at costa; antemedial band indistinct except between anal vein and inner margin; postmedial band vague, limited basally and distally by a series of patches of dark scales between the veins, the median portion cinereous except between Cu_2 and the anal vein where it is white; subterminal line irregular, pale, bordered inwardly by some rufous spots, those nearer the inner margin the most heavily marked; terminal line of weak black crescents; fringe of dark-tipped scales, but narrowly white at veins; a dark, triangular spot extending inwardly from termen in area of the branches of the medial vein and another dark patch on the costa shortly basad of apex; reniform moderate, vague, mostly of pale, cinereous scales; orbicular large, oblique, outlined with black except open toward costa, central portion white; the area between the reniform and orbicular black; a black basal dash present, extending to antemedial band, followed distally by a heavy, black median bar. Hind wing lightly

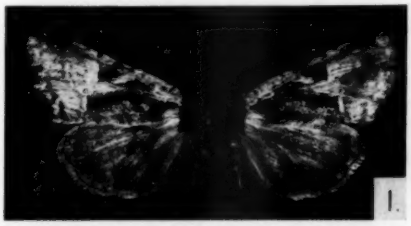


Fig. 1.—Type, male, *Meropleon titan*, n. sp. (1.5 × natural size.)

suffused with fuscous; terminal line black; fringe of dark-tipped scales, but paler than fringe of forewing. Undersurface of forewing dark grey, cell appearing darker due to a patch of dark hairs. Hind wing below, whitish, weakly flecked with fuscous scales; a moderate, black discal spot present. Length of forewing, 19 mm.

Male genitalia similar to those of *Meropleon diversicolor* (Morrison) but larger and aedeagus distinct. Aedeagus with two spatulate lobes from the aedeagal shaft and a third lobe on the vesica (see Fig. 2). In *diversicolor* the aedeagus has but one external spatulate lobe.

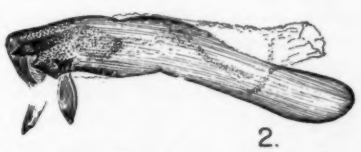


Fig. 2.—Lateral view of aedeagus of *Meropleon titan*, n. sp. (13.5 × natural size.)

Type, male, Clemson, S. C., October 7, 1956, Frances McAlister, in the U. S. National Museum, Washington, D. C. Type number 63458. One male paratype, Clemson, S. C., September 19, 1957, Frances McAlister in the collection of the Department of Entomology, Clemson Agricultural College, Clemson, S. C.

This species is obviously related to *M. diversicolor* (Morr.) but is readily separated by the larger size, the presence of a black basal dash in the anal fold of the forewing, the asymmetrically bipectinate antennae of the male and the distinctive aedeagus of the male.

HERPETOLOGY.—*Contributions to the herpetology of Maryland and Delmarva, No. 17: Southeastern herptiles with northern limits on coastal Maryland, Delmarva, and New Jersey.* CLYDE F. REED, Reed Herpetorium, Baltimore, Md.

(Received July 22, 1957)

While studying the flora of southeastern United States, the author has observed that various southern herptiles also find their northern limits in our region. About 75 species of plants with a general distribution southward to Florida have their northern limit in Maryland, on Delmarva or in southern New Jersey. Most of these species of plants having the said distribution are found on the Outer Coastal Plain. Their northern limit, known at the present time, has been annotated in a botanical paper by the author dealing with the northern extensions of the southern coastal flora.

Most notable of the species of plants finding their northern limit in Maryland or on the Delmarva Peninsula are: *Taxodium distichum* (cypress), *Tillandsia usneoides* (Spanish moss), *Quercus virginiana* (live oak), *Xanthoxylum clava-herculis*, *Bignonia capreolata*, *Trillium pusillum* var. *virginianum*, *Berchemia scandens*, *Symplocos tinctoria*, *Borrichia frutescens*, and *Passiflora incarinata*.

There are 21 herptiles that have a similar southern Coastal Plain distribution and have their northern limitations in Maryland, on Delmarva or in southern New Jersey. A couple of the species range more northward into southern New England and Massachusetts. However, some of the southern Coastal Plain plants also range northward into New Jersey, Long Island, and Massachusetts.

1. *Rana virgatipes* Cope. Atlantic Coastal Plain from southern New Jersey to southeastern Georgia. New Jersey (Atlantic, TYPE LOCALITY; Burlington, Monmouth, Essex, Cape May, Mercer, Ocean); Delaware (Sussex); Maryland (Dorchester, Worcester, and Charles). See Reed, *Contributions to the herpetology of Maryland and Delmarva, No. 16*, in Herpetologica, 1957. Map 1 (●).

2. *Hyla femoralis* Sonnini and Latreille. Lower Coastal Plain from southern Maryland and southeastern Virginia to eastern Louisiana. Maryland (Calvert: Battle Creek, see Fowler, Maryland Journ. Nat. Hist. **17**(1): 6–7, 1947). Map 1(×).

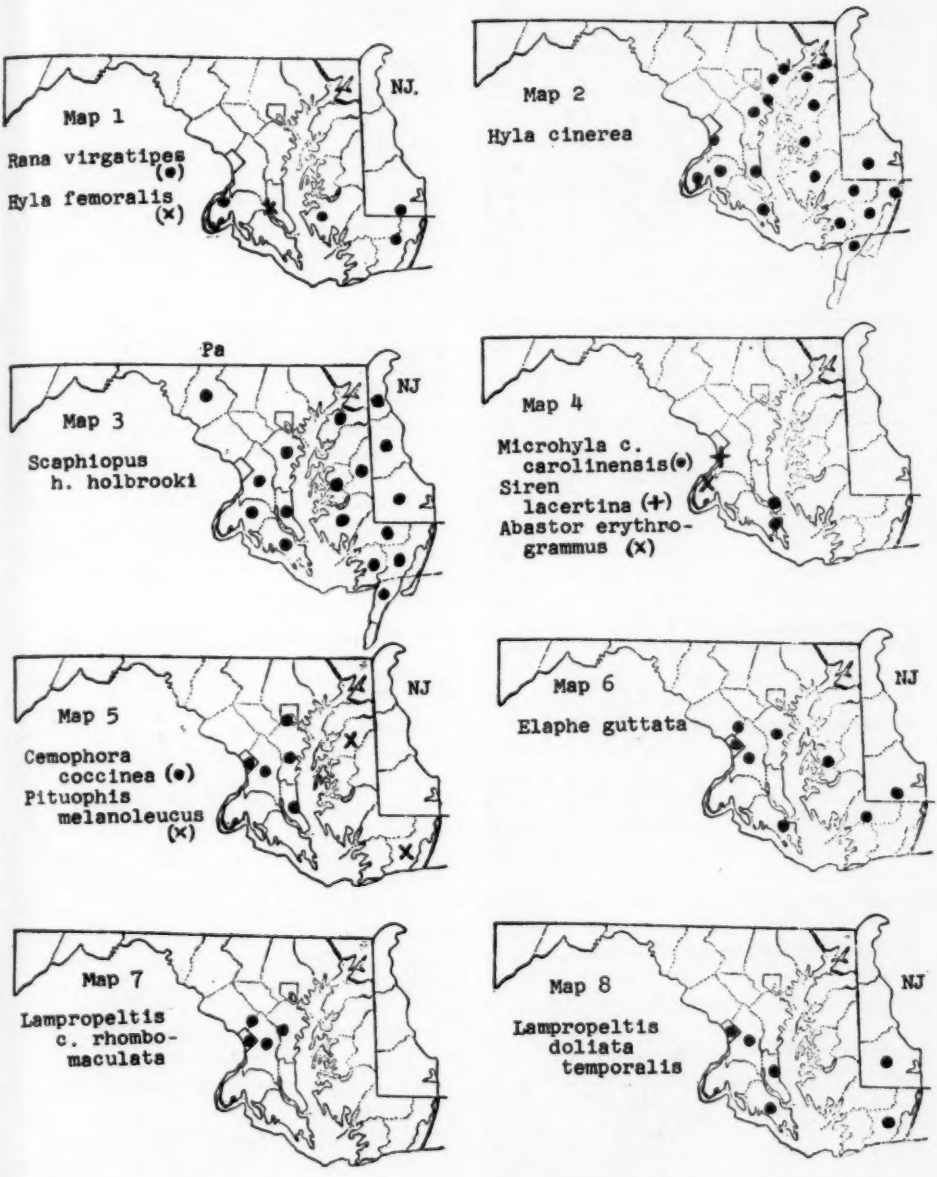
3. *Hyla cinerea* (Schneider). Coastal Plain from Delaware and Maryland south through the lowlands of the Atlantic and Gulf States from Virginia to Texas; north in the Mississippi Basin to southern Illinois. Delaware (Sussex), Maryland (Cecil, Kent, Queen Annes, Talbot, Dorchester, Harford, Baltimore (coastal), Somerset, Wicomico, Worcester, St. Marys, Charles, Calvert, Anne Arundel, Prince Georges). See Reed, Journ. Washington Acad. Sci. **46**(10): 328–332. 1956. Delmarva Virginia (Accomac and Northampton). See Reed, Journ. Washington Acad. Sci. **47**(3): 89–91, 1957. Map 2.

4. *Hyla andersoni* Baird. Southern New Jersey; Southern Pines, N. C.; Anderson, S. C.; coastal Georgia. It is interesting to note that *Rana virgatipes* has also been recorded from southern New Jersey, from Southern Pines, N. C., and from coastal Georgia. See Davis, Amer. Nat. **41** (481): 49–51, 1907.

5. *Scaphiopus holbrooki holbrooki* (Harlan). Eastern United States from Massachusetts to Florida, west to Louisiana, eastern Texas, and Arkansas, north in the midwest to West Virginia, southern Ohio, Indiana, and Illinois. Although this toad ranges northward from our region in Maryland into central Pennsylvania by way of the Frederick Valley and the coastal recesses in that region, it is limited to the coastal regions. See Reed, Herpetologica **12**(4): 294–295. 1956. Maryland (Frederick, St. Marys, Charles, Calvert, Prince Georges, Anne Arundel, Worcester, Wicomico, Somerset, Dorchester, Talbot, Caroline, Kent); Delaware (Sussex, Kent, New Castle) and Delmarva Virginia (Accomac). Map 3.

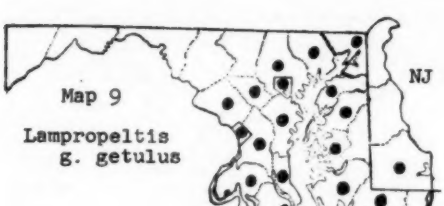
6. *Microhyla carolinensis carolinensis* (Holbrook). Maryland to Key West, Fla., west and north to Illinois and Missouri, Kansas, eastern Oklahoma, and eastern Texas. Maryland (Calvert and St. Marys). See Noble and Hassler, Copeia 1936(1): 63–64; Mansueti, Bull. Nat. Hist. Soc. Maryland **12**(3): 33–34. 1942. Map 4(●).

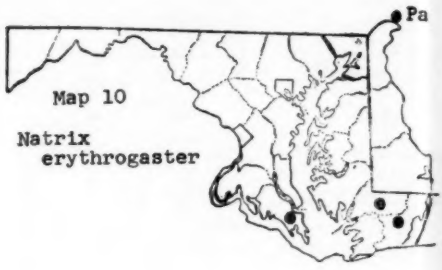
7. *Siren lacertina* Linnaeus. Maryland and

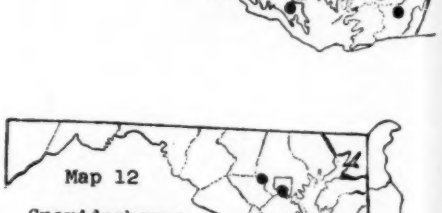


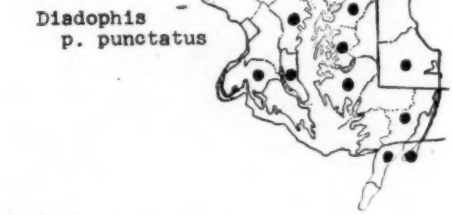
Virginia on the west side of Chesapeake Bay, coastal North and South Carolina, southern Georgia and Alabama, throughout Florida. Maryland and District of Columbia (Potomac Flats). See Hay, Proc. Biol. Soc. Washington **15:** 121–146. 1902. Map 4(+).

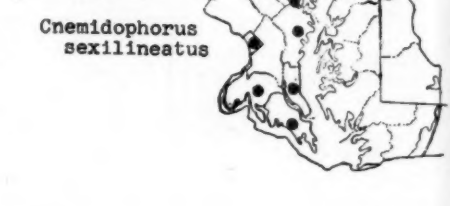
8. *Abastor erythrogrammus* (Latreille). Maryland (Charles) through the Lower Atlantic Coastal Plain to central Florida and Alabama. Maryland (Charles: 4 miles South of Indian Head, Stump Neck, between Mattawoman and Chicomuxen Creek. *H. Hassler.*) See McCauley,

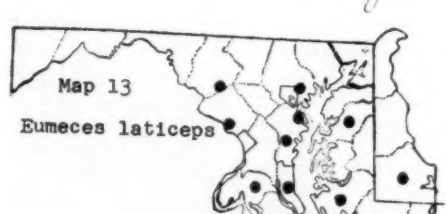


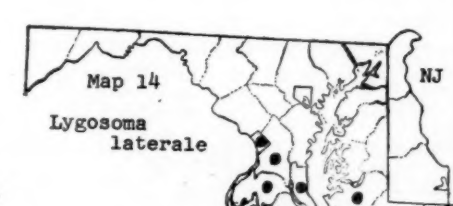












The reptiles of Maryland and the District of Columbia, 1945; Copeia 1939(1): 54. Map 4(×).

9. *Cemophora coccinea* Blumenbach. Southern New Jersey, southward through the Atlantic and Gulf States, west to Louisiana and Oklahoma. Maryland (Calvert, Baltimore, Prince Georges, Anne Arundel), District of Columbia. See Reed, *Contributions to the herpetology of Maryland and*

Delmarva, No. 8. Snakes of Maryland, etc. 1956. Map 5(●).

10. *Elaphe guttata guttata* Linnaeus. Southern New Jersey to the tip of Florida, west to northeastern Mexico, north in the interior to Kentucky and Missouri and in the west to western Colorado and Great Salt Lake. Maryland (Prince Georges, Anne Arundel, adjacent Montgomery, St. Marys, Talbot, Wicomico), District of Columbia and Delaware (Sussex). See Reed, *Contributions to the herpetology of Maryland and Delmarva, Nos. 8 and 11*. 1956. Map 6.

11. *Lampropeltis calligaster rhombomaculata* Holbrook. Southern Maryland and Virginia, south to eastern Tennessee and central Florida, and westward through Alabama and Mississippi. Maryland (Prince Georges, Anne Arundel, adjacent Montgomery) and District of Columbia. See Reed, *Contributions to the herpetology of Maryland and Delmarva, No. 8*, 1956. Map 7.

12. *Lampropeltis doliata temporalis* Cope. Southern New Jersey, Delaware, and Maryland through Virginia and North Carolina. Maryland (Prince Georges, Calvert, St. Marys, Worcester), District of Columbia and Delaware (TYPE LOCALITY). Map 8.

13. *Lampropeltis getulus getulus* (Linnaeus). Southern New Jersey to northern Florida, westward to southeastern Alabama. Maryland (Garrett, Montgomery, Prince Georges, Charles, St. Marys, Calvert, Anne Arundel, Howard, Baltimore City, Baltimore, Harford, Cecil, Queen Annes, Kent, Talbot, Dorchester, Wicomico, Worcester, Somerset), District of Columbia, Delaware (Sussex), and Delmarva Virginia (Accomac and Northampton). See Reed, *Contributions to the herpetology of Maryland and Delmarva, Nos. 8 and 11*. 1956, and *Contributions to the herpetology of Virginia, No. 3*, in Journ. Washington Acad. Sci. **47**(3): 89–91. 1957. Map 9.

14. *Natrix erythrogaster erythrogaster* Forster. Maryland southward in the Coastal Plain and adjacent Piedmont to northern Florida. Maryland (St. Marys, Wicomico, and Worcester). See Reed, *Contributions to the herpetology of Maryland and Delmarva, No. 8 and 11*. 1956. Map 10.

15. *Diadophis punctatus punctatus* Linnaeus. Coastal Maryland to Florida. Maryland (Charles, Calvert, Anne Arundel, Queen Annes, Talbot, Dorchester, and Worcester), Delaware (Sussex), and Delmarva Virginia (Accomac). See Reed, *Contributions to the herpetology of Maryland and Delmarva, Nos. 8 and 11*. 1956. Map 11.

16. *Pituophis melanoleucus melanoleucus* (Daudin). New York (Rockland) south to South Carolina and westward to eastern Tennessee. Maryland (Queen Annes and Worcester). The New York locality is just north of the New Jersey border. Map 5(×).

17. *Cnemidophorus sexlineatus* (Linnaeus). Maryland to Key West, Florida, west to eastern Texas, north in the interior to Indiana and Illinois, and along the rivers in southern Wisconsin and Minnesota, and through Oklahoma to South Dakota and southeastern Wyoming. Maryland (Anne Arundel, Calvert, Charles, St. Marys, Baltimore and Baltimore City) and District of Columbia. Absent from the Delmarva Peninsula. See Reed, *Contributions to the herpetology of Maryland and Delmarva, No. 6. The Lizards of Maryland*, etc. 1956. Map 12.

18. *Eumeces laticeps* (Schneider). Southern Pennsylvania and Delaware, southward to Florida, westward through Ohio, Indiana, Illinois and southeastern Missouri, west to eastern Kansas, eastern Oklahoma and eastern Texas. Maryland (Anne Arundel, Baltimore, Calvert, St. Marys, Charles, Montgomery, Queen Annes, Dorchester, Frederick) and Delaware. See Reed, *Contributions to the herpetology of Maryland and Delmarva, No. 6*, 1956. Map 13.

19. *Lygosoma laterale* (Say). Southern New Jersey and southeastern Pennsylvania southward; southern Ohio, Indiana, Illinois, and northern Missouri; westward to eastern Kansas, eastern and central Oklahoma, and Texas. Maryland (Prince Georges, Calvert, Charles, St. Marys, Dorchester and Worcester,) District of Columbia and Delmarva Virginia (Accomac and Northampton). See Reed, *Contributions to the herpetology of Maryland and Delmarva, Nos. 6 and 11; Contributions to the Herpetology of Virginia, No. 3*, in Journ. Washington Acad. Sci. **47**(3): 90, 1957. Map 14.

Note: *Eumeces inexpectatus* Taylor ranges as far north as the northern shores of Northern Neck, Virginia, which is the southern shore of the Potomac River. The Maryland line extends to the southern bank of the Potomac River. Northumberland County, Va., 1 mile north of Heathsville, near Clarks Mill, May 15, 1954, Reed 854. See Reed, Herpetologica **12:** 136. 1956, and *Contributions to the herpetology of Virginia, No. 2, The herpetofauna of Northern Neck, Virginia*, in Journ. Washington Acad. Sci. **47**(1): 21–23. 1957.

20. *Pseudemys floridana concinna* (LeConte). Atlantic Coastal Plain from Maryland to Alabama, mostly above the Fall Line and into eastern Tennessee. Maryland (Montgomery, Prince Georges, Charles) and District of Columbia. See Reed, *Contributions to the herpetology of Maryland and Delmarva, No. 7*. 1956. Map 16.

21. *Malaclemys centrata concentrica* (Shaw). Coastal Plain from Massachusetts to North Carolina, including Delaware and Chesapeake Bays and to Florida. Maryland (Calvert, Somerset, Caroline, Queen Annes, Talbot, Wicomico, Dorchester, Kent, and Worcester), District of Columbia, Delaware (Sussex and Kent) and Delmarva Virginia (Accomac and Northampton). See Reed, *Contributions to the herpetology of Maryland and Delmarva, Nos. 7 and 11*. 1956; *Contributions to the herpetology of Virginia, No. 3*, in Journ. Washington Acad. Sci. **47**(3): 89–91. 1957. Map 15.

Incidentally, there are four deep-sea turtles from tropical and semitropical south Atlantic waters that find their way up the Atlantic Coastal area as far north as Maryland, Delaware, Massachusetts, and Nova Scotia. Specimens of these have been recorded from the lower Potomac River and the Chesapeake Bay or from Delaware Bay in our region. These turtles are usually stragglers that come up the Gulf Stream from time to time. However, large numbers have been seen and at times have been caught in the Chesapeake Bay off Virginia and southern Maryland. As many as five *Caretta caretta* have been caught in the fish nets in a single day by a single fisherman. Capt. W. J. Biddlecomb of Fairport, Va., reports many of these and other deep-sea turtles in the waters off Great Wicomico Light House. The records for these turtles are recorded in Reed, *Contributions to the herpetology of Virginia, No. 2, The herpetofauna of Northern Neck, Virginia* (Journ. Washington Acad. Sci. **47**(1): 21–23. 1957). Also, Maryland and Delmarva specimens are annotated in *The contributions to the herpetology of Maryland and Delmarva, Nos. 7 and 11*. 1956.

22. *Caretta caretta caretta* (Linnaeus). Atlantic and Gulf coasts of United States from Maryland and the Chesapeake Bay southward. Maryland (Calvert, lower Potomac River and Chesapeake Bay, Dorchester and Worcester), Delaware (Sussex), and Delmarva Virginia (Accomac and Northampton). See Reed, *Contributions to the herpetology of Virginia, No. 2*, l.c., 1957.

23. *Chelonia mydas mydas* (Linnaeus). Tropical and subtropical Atlantic waters, northward to temperate zones. Maryland (Calvert). See Reed, *Contributions to the herpetology of Maryland and Delmarva, No. 7*. 1956.

24. *Dermochelys coriacea* (L.). Atlantic and Gulf coasts, occasional as far north as Nova Scotia. Maryland (Calvert and Chesapeake Bay) and Delmarva Virginia (Accomac). See Reed, Journ. Washington Acad. Sci. **47**(1): 21–23. 1957, for picture of 700-pound specimen caught off Northern Neck, Va.

25. *Lepidochelys* (*olivacea*) *kempi* (Garman). Atlantic coast north from tropical waters to Massachusetts. Maryland (St. Marys, lower Potomac River and Chesapeake Bay). See Reed, *Contributions to the herpetology of Maryland and Delmarva, No. 7*. 1956; *Contributions to the herpetology of Virginia, Nos. 2 and 3*. 1957, both in Journ. Washington Acad. Sci. **47**(1) and **47**(3), respectively.

The 21 herptiles listed above represent about 25 percent of the species in the herpetofauna of Maryland and Delmarva. Seven of these find their northern limit in southern Maryland (the Coastal Plain area west of Chesapeake Bay); eight of the species, found on the Coastal Plain, find their northern limit in coastal New Jersey; two range into southeastern Pennsylvania along the Delaware River. The accompanying maps indicate the counties in Maryland, Delaware, the District of Columbia, and Delmarva Virginia where the various species have been collected. References are given with each species where an annotated list of specimens may be found. Contributions 5 through 11 to the *Herpetology of Maryland and Delmarva* have been published by the author and are available from the Reed Herpetorium, 10105 Harford Road, Baltimore 34, Md.

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